



# The BuildingGreen Report™

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## Affordable Housing and Sustainable Design: The Goals Are Aligned

**Green building is not just for those with means.**

by Nancy Eve Cohen

There is a vast, unmet need for affordable housing in the U.S.

More than eight million extremely low-income households pay more than half of their incomes to rent their homes. In addition, more than a half million people in the U.S. were homeless last year.

Andrew Spofford, chief of staff of the nonprofit Preservation of Affordable Housing (POAH), says that right now the U.S. is “serving something like one in four families that really need housing assistance.”

The National Low-Income Housing Coalition has identified a shortage of 7.4 million homes that are affordable and available.

While housing advocates are pushing to build more and more homes for low-income people, sustainable design advocates say the affordable housing that we do build should be energy efficient, healthy, and durable.

“People with low incomes are the ones who need it the most,” says Krista Egger, director of initiatives at Enterprise Community Partners. If your income is very low and you live in housing that has low utility bills and is healthier, “you are going to benefit at a greater incremental degree ... than if you have a lot of disposable income,” says Egger.

But despite the desire to build green, the priority for state housing finance agencies is to build more affordable units.

Many designers and architects told BuildingGreen that it takes intent, hard work, and careful analysis to figure out what to change on a project in order to gain a more durable, healthier, and affordable building. Some scale back the size of units in order to find funds to increase energy efficiency and indoor air quality. Others cut the landscaping budget. Some invest time researching lower-cost materials that are still of good quality. These tradeoffs between cost and ‘green’ are made within the confines of a tight budget, and with the goal of providing housing for the most needy that will be healthy and affordable for decades.

Egger maintains there are many things that can be done to an affordable housing property to make it healthier for residents and perform better “that do not cost a cent.” She points to low-VOC paint, low-flush toilets, and the investments in energy efficiency that pay dividends in the long run. “I do



Photo: Preservation of Affordable Housing

*Billings Forge Apartments in Hartford, Connecticut is a mixed-income community that was renovated by Preservation of Affordable Housing in 2017. It has 102 affordable units.*

not think it is a question of ... should I build sustainable or should I build affordable. You can do both at the same time,” says Egger.

But for some developers, the bottom line is still the bottom line. There is only so much funding that is available to build affordable housing, and there is an enormous need. “For better or worse, my approach on a deal-by-deal basis is how can I green up my project enough to satisfy QAP requirements (state funding requirements) without killing the budget,” wrote Peter Serafino to BuildingGreen. He is a nonprofit developer with Way Finders



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in Springfield, Massachusetts. “Not an ideal strategy. It is reflective of financial reality.”

## Where Affordability and ‘Green’ Align

Nonprofit developers are often also the long-term owners of the projects they build. That creates a built-in incentive for durability and energy efficiency because much of the federal funding requires owners to keep buildings affordable for at least 30 years. Some states extend that to 50 years or more.

When the nonprofit is paying the utility bills, it makes fiscal sense “to plan for as much efficiency as possible because you are going to get it back,” says Sunshine Mathon, CEO of Piedmont Housing Alliance in Charlottesville, Virginia. “On the mission side, anything we can do to help facilitate a more stable economic environment for the residents that we serve also furthers the mission.”

Laurel Blatchford, senior vice president and chief program officer for Enterprise Community Partners, says the myth that sustainable housing is, in her words, “wildly boutique and expensive,” isn’t true. “What we see across the country again and again is those investments that are made in greener, more sustainable technologies or improvements really see enormous benefits over the life of a project.” Blatchford says, “From our perspective, it’s not only better for the environment; the operating costs are lower, which means it’s more likely the tenants will continue to have affordable rent.”

### Promoting pride, health, and social connectivity

Besides ensuring that affordable buildings will last a long time with lower utility bills, advocates of green affordable housing say they should also contribute to the physical and mental health of the residents.

Gina Ciganik, the CEO of the Healthy Building Network and a former nonprofit housing developer, says green buildings should build a sense of community and promote healthy



Photo: Preservation of Affordable Housing

Melpet Farm Residences in Dennis, Massachusetts, has 27 affordable units and is pursuing net zero. It was designed by Brown Lindquist Fenuccio & Raber Architects.

activities. For instance, she says, they should be designed to encourage people to be more active.

In The Rose, a mixed-income building Ciganik helped develop in Minneapolis, murals and windows light up the staircases “so they are bright and airy, and you feel like you want to use them and you are not afraid to go in there,” says Ciganik.

Sophia Ali—along with her husband and their four children—lives in a two-bedroom apartment in The Rose. She says her husband always takes the children up the stairs, teaching them it is a healthy choice. She laughs and explains she takes the elevator because she’s the one who carries home the groceries.

Besides the stairs, The Rose also has a community garden program, where Ali’s children are learning to grow vegetables. Sometimes they bring home salad greens. “I love the garden,” says Ali. “My kids talk about it over and over.” And the garden is also resource efficient: rainwater from the building is treated and used to water the plants.

As a mother, Ali says her top priority is her kids’ health, and she appreciates the countertops and paint made of lower-toxicity materials. “I just clean my place and let them play free,” Ali says about her children. “I’m not worried about what they’re picking up.”

Jonathan Rose is president of Jonathan Rose Companies, which develops green, affordable housing and renovates existing buildings to make



them greener. Rose says in many cases shifting to nontoxic materials has no extra cost; it just provides benefits. “Literally, I have been walking through our buildings,” explains Rose, “and have had mothers come up to me and say, ‘My child was going to the hospital every three months with asthma attacks. Ever since we moved into this building, she has never had an asthma attack again.’”

## Health impact studies

Although more affordable housing is being built to green specifications, there are few studies with large numbers of participants that document the impact on health.

Understanding the health impacts is critical in affordable housing. Children from low-income families are more likely to suffer from lead poisoning. Asthma rates are higher in children from low-income communities.

A [study](#) published in the *American Journal of Public Health* in 2015 looked at the health benefits of green public housing in Boston and found that asthmatic children had “substantially lower risk of asthma symptoms, asthma attacks, hospital visits and asthma-related school absences” compared to “children living in conventional public housing.”

Since 2011 the National Center for Healthy Housing (NCHH) has conducted [four studies](#) assessing the health impacts of living in low-income housing that has undergone green renovations. Three of the studies were based on self-reporting by 50 to 60

residents about their health before and after they lived in buildings with green renovations for a year or more. One study included 400 residents.

“We have seen improvements in general health and non-asthma respiratory symptoms,” such as bronchitis and sinusitis, says Jill Breyse, a public health researcher with NCHH. “Certainly, from a respiratory standpoint ‘green’ has a positive impact.” The studies also showed an improvement in the mental health of residents. The researchers did not find any negative health impacts from green housing.

“All green buildings standards should require health requirements” is the conclusion of several of NCHH’s studies.

Breyse explains that not all green building certifications *require* healthy standards. “Our hope is that these various green criteria could be strengthened from a health standpoint by making them requirements and not just options.”

Looking ahead, more data on health outcomes is expected in a few years. Enterprise Community Partners and NCHH are conducting a study in three cities (New York, San Francisco, and Chicago) with the goal of enrolling 1,200 households and retaining 700 of them over the course of a year. (It is a challenge to retain study participants because of the rate at which tenants move.) The study is specifically enrolling adults and children with asthma.

## What Is Affordable When It Comes to Housing?

The definition of affordable housing depends on the housing market. What’s affordable in San Francisco is probably not affordable in Billings. According to most government



Photo: Tim Griffith

*Rene Cazenave Apartments in San Francisco provides affordable housing with supportive services for the formerly chronically homeless. It was designed by Leddy Maytum Stacy Architects and Saida + Sullivan Design Partners.*

affordable housing programs, an affordable home should cost no more than 30% of a given household’s income.

Federally funded affordable rental housing usually targets households earning 60% of the Area Median Income (AMI) and below. Federally funded affordable homeownership targets families making 80% of AMI and below. This is the upper end of affordability. Many affordable housing developers also build for people earning much less: 40% or even 30% of their area median income.

So, how much is the rent in an affordable building? Let’s take [Austin, Texas for example](#), where the median income for a family of four is \$81,400 a year. To be eligible for federally funded affordable housing, a household would be earning 60% of AMI, or \$48,850 (or less). The rent for a four-person household in housing built with federal funds would be no more than 30% of the household income. So for a household earning 60% of AMI in Austin it would be \$1,221 a month. If the housing is offered to extremely low-income households earning 30% of AMI, the rent would be \$615 a month. If the tenant is paying the utilities, the rent is reduced by the average cost of utilities.

## History: as quality improved, discrimination remained

Given the low rents that an owner can charge, how does that impact design?



Photo: Foundation Communities

*M Station Apartments is a 150-unit affordable housing community in Austin, Texas, for families whose average household income is \$25,000 a year. It was built by Foundation Communities and is LEED Platinum certified.*



Photo © Abraham Ravett, 1982

*"Windows" A view of Building 4A at Trump Village in Brooklyn, New York, as seen from the 12th floor of Building 3a in 1982.*

Historically, the emphasis has been on quantity, not quality.

When the first tenements were built in New York City in the 1800s, developers "stuffed as many units as they could into as small a building envelope as possible," says Thomas Barrie, professor of architecture at North Carolina State University. Multiple families shared apartments. The apartments were too hot in the summer and poorly heated in the winter, and many of the interior rooms had no windows, which meant poor air circulation and conditions that helped spread disease.

When the first public housing was built, in the 1930s, designers started to pay more attention to solar orientation, and windows became a priority.

At about the same time, some trade unions built housing. In New York City, the Amalgamated Clothing Workers Union built one of the first housing cooperatives in the country with courtyards, educational programs, and community activities. Today, it still houses nearly 1,500 moderate-income households. This is one of many examples where affordable housing creates community.

By the 1940s through the 1960s, the construction of new low-cost housing was mostly done by the federal government in partnership with municipal housing authorities.

Nicholas Bloom, associate professor of social science at New York Institute of Technology, says the thinking was to build on only 20% to 30% of a site. "The architectural ideal of the time is: create density, but with openness around it." Known as "towers in the park," Bloom describes public housing in big cities as mostly "very tall buildings, sometimes low rise, relatively small windows, but lots of them." Inside, Bloom

says the materials were durable, but institutional.

From the outside, Bloom says these buildings may seem alienating, but "if two to three generations of your family live in a building, you don't feel isolated."

During this period, the federal government had a major stake in providing housing. Barrie, who runs the Affordable Housing and Sustainable Communities Initiative at North Carolina State, says the government "had a real commitment to the public good. They not only provided so-called decent housing, but it came with services as well."

In the 1960s and 1970s, affordable housing was also built for the middle class in New York. Funded by the state's Mitchell-Lama Housing Program, developments like Coop City in the Bronx, New York, with more than 15,000 units, and the 22-story Trump Village in the Brighton Beach neighborhood of Brooklyn, New York, had several tall buildings with large apartments. When they built Coop City, designers created large super-blocks and surrounded the buildings with green, open space. Trump Village (built by Fred Trump, President Donald Trump's father), included courtyards where residents gathered on benches, children played on swings, and city parks and the ocean boardwalk beckoned from nearby.

When Abraham Ravett and his parents moved to Trump Village in the early 1960s, it was a huge improvement over the immigrant family's fourth-floor walkup in the Brownsville section of Brooklyn. Ravett, now a film and photography professor at Hampshire College, remembers the first time he walked into the large living room with bay windows, "The light, it was spectacular" compared to the darkness of their former apartment. "It was a step up," recalls Ravett, "in terms of openness, of space, and certainly of breathing room because you could walk to the ocean!"

But Ravett doesn't remember any people of color living there.

About five years after Trump Village was built, the Fair Housing Act of 1968 was passed, and civil rights and housing activists were working to stop discrimination in housing. "Testers" sought evidence of discriminatory practices. These were white activists who posed as people seeking housing, immediately after prospective African American tenants had been turned away. The "testers" often found *they* were offered an apartment when people of color were *not*.

The Mitchell-Lama buildings were privately managed. At Trump Village "they did things to encourage white occupancy and discourage minorities," says Bloom. "In other places like Coop City, they quickly shifted from an integrated tenancy to majority minority."

## **Government Financing of Affordable Housing**

Today, the government no longer builds affordable housing, but it does help fund it. For more details, read [Financing Affordable Housing: Not for the Faint of Heart](#).

Low Income Housing Tax Credits (LIHTC), issued by the IRS and distributed to housing projects by each state, fund most of the affordable housing built in the U.S. Last year alone, the tax credits provided nearly \$8 billion in funding for affordable housing.





Photo: PFRA + LDA

*Live 155 is a 70-unit energy-efficient building in Northampton, Massachusetts, with photovoltaic (PV) panels on the roof that are projected to cover a third of the energy use. It has 47 affordable efficiency and one-bedroom apartments and is designed by Peter Frothingham Registered Architect and LDn Architecture & Interiors.*

Even so, housing advocates say there aren't enough tax credits to meet the need for affordable housing, making it very competitive for projects to secure them.

Once an affordable housing project is awarded tax credits by the state, the developer sells them to banks and other large businesses that buy the tax credits to lower their tax liability.

Banks and other investors get a dollar-for-dollar reduction on their taxes for ten years. If they invest \$10 million in a housing project, their taxes are reduced by one million dollars every year for ten years.

The value of the tax credits is determined by the market, and it's different in each region. In the past year, President Trump's campaign promise to lower corporate taxes reduced the market value of the tax credits. For more on the political impacts on the financing of affordable housing, see [Financing Affordable Housing; Not for the Faint of Heart](#).

Most federal funding for affordable housing is distributed by the states, including the LIHTC program. Some states award more tax credits to green housing proposals and some don't.

### **QAPs, potential policy levers for green affordable housing**

Every state finance housing agency has its own criteria for awarding LIHTC to affordable housing projects. These criteria are known as a Qualified

Allocation Plan (QAP). A QAP has the potential to make affordable housing more green, energy efficient, and healthy. The requirements for sustainable affordable housing vary from state to state.

Seventy-five percent of the projects funded by the LIHTC program in 2013 made a commitment to a state housing finance agency that they would follow a whole green building rating system (such as Energy Star or LEED), according to a survey conducted by Enterprise Green Communities. It doesn't mean these projects got certified. Asking for certification is still an emerging practice among states.

It's up to each state to decide whether to include green building criteria, with the exception of energy efficiency, which is a federally-mandated selection criteria. In practice, most of the states require affordable housing projects that receive funding to comply (or commit to comply) with the International Energy Conservation Code (IECC).

Today, "the majority of publicly funded housing achieves a baseline of green," says Walker Wells, vice president of programs for Global Green, a nonprofit dedicated to sustainable, resilient communities.

"Most states are doing quite well in incorporating sustainability and preserving sustainability once it is put into the QAP," says Wells. "Then there are some instances of backsliding and some instances of perpetual low performance. But the number of low performers shrinks every year."

### **A green report card for state agencies**

Global Green grades each state housing finance agency annually on the green criteria of their QAPs, issuing a 'report card.' Eleven states got an A- or higher in 2016. Most were in the B to A- category. Two received a failing grade.

As part of its analysis, Global Green looks at whether each state addresses smart growth, energy efficiency, resource conservation, and health protection, and how it does that.

Wells says when his group first started issuing the report card in 2005, there were states with QAPs that had no reference at all to any energy code. At first, QAPs focused on hazard avoidance: not building affordable housing where residents would be exposed to toxic emissions. Next, QAPs began to incorporate smart growth policies, such as proximity to

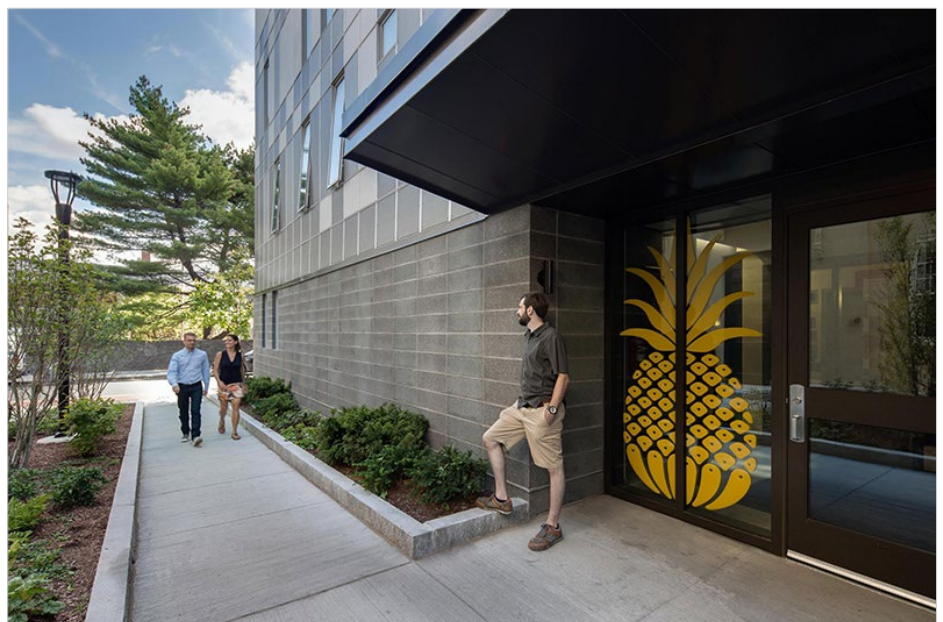


Photo: Ed Wonssek

*Temple Place in Cambridge, Massachusetts, has 40 affordable units and is certified by Enterprise Green Communities. It was designed by HMFH Architects, Inc.*

transit, encouraging urban infill, and the reuse of brownfields. During the George W. Bush administration, the QAPs began to require some level of energy efficiency.

Global Green offers bonus points in its grading analysis for emerging best practices. In 2016, bonus points were awarded to a state agency that required projects to commit to third-party certification such as LEED, EarthCraft, GreenPoint Rated, or Enterprise Green Communities.

Last year, as a condition of affordable housing financing, 22 states either required certification by Enterprise Green Communities or offered optional extra points if a project was certified or met all of the standards of certification.

Global Green also awarded bonus points last year if a state agency recommended or required projects be designed to promote physical activity by occupants.

Egger agrees that health is an area that deserves more focus. She also suggests that after projects are completed they should be evaluated using performance data. "If we could look at the actual utility data for energy and water, and maybe even some indoor air quality components ... I think that would be really powerful." Global Green awards bonus points to state housing finance agencies that "recommend or require energy benchmarking."

Looking ahead, Global Green wants states to integrate climate change preparedness into their QAP criteria. This might include battery backup for photovoltaic systems or planning for a building to be a place where other people could evacuate in a natural disaster "so these investments become a stronger asset in the community," says Wells, "not just serving the residents."

## A look at Pennsylvania, a top-rated state

Pennsylvania earned an A in Global Green's analysis. Under the

Pennsylvania Housing Finance Authority's QAP, affordable housing projects can earn points for being certified by one of three national green building programs: LEED, the National Green Building Standard, or Enterprise Green Communities. It also gives points for a reduced Home Energy Rating System (HERS) Index. (The [HERS Index](#) is referenced in Energy Star and other programs.)

In 2015, the state became the first to include Passive House design as part of its QAP criteria. For the projects that commit to Passive House, the Pennsylvania Housing Finance Agency (PHFA) does not require them to get certified after construction is finished. It does require precertification beforehand.

Stan Salwocki, manager of architecture and engineering for PHFA, says a green proposal doesn't guarantee funding, but "it makes it more desirable from our standpoint and from a tenant's standpoint. We tend to view things from the perspective of the person who has to live there."

## What some developers and designers say

The impact of QAPs varies from state to state, according to developers and designers who spoke with BuildingGreen, but most agree QAPs have the *potential* to make change. "Unless there is an expectation and a requirement for a certain level of sustainability in the QAP," says Mathon, "the buildings aren't going to get there on their own."

Spofford says QAPs have a clear impact on the kinds of projects developers propose. "In most states, I think developers are pushed to build greener than they otherwise would," he says, "because that's the only way



Photo: Preservation of Affordable Housing

*Billings Forge Apartments in Hartford, Connecticut is a mixed-income community with 102 affordable units and 11 that are market rate. Preservation of Affordable Housing renovated it in 2017.*

to compete successfully for the limited funding."

However, the government's priority is to build as much housing as is possible because the need for affordable housing is enormous.

Mathon, who developed affordable housing in Texas for a decade, says, "The conversation around priorities in the QAP around sustainability ... can fall by the wayside under the pressure of just getting as many units built as possible." Mathon says although you can get points under the Texas QAP for certain aspects of green building, you can also get points for doing other things. "It is not truly incentivized in the Texas QAP to build for sustainability. It's one option out of many choices." Texas earned an F in Global Green's QAP analysis.

Wells is optimistic that the QAPs have helped make green building standards, which are ready to be broadly implemented, standard practice.

But he adds a word of caution. "This is a lot of public money. It needs to be well spent," says Wells. "It's not a program to support the most innovative, the most ... cutting edge strategies." Wells says we have to be very thoughtful "and not be experimenting with public money and not be experimenting with the poor."



## The Role of Green Building Certifications

Committing to a green building certification may help attract investment. It can signal to an investor that a project is being developed with intention and with an eye on the long term, reducing the risk of investment.

Enterprise Green Communities is the first green certification program to focus on affordable housing. The program helps designers and developers build green homes at reasonable prices so that there is “equitable access to them,” says Egger, who oversees the Green Communities initiative.

The goal “is to make systematic change, to try to have people with low and moderate incomes be able to experience the benefits of living in a green home and in an environment that allows them access to opportunity,” says Egger.

Besides water conservation, materials, and energy efficiency, Green Communities integrates location, resident engagement, and healthy living into the design.

Egger says choosing healthier materials is relatively easy, such as using low-VOC paint. But other

aspects of the program are more challenging because they require people to act differently. “Changing behavior is really hard,” says Egger.

For instance, Enterprise calls for a collaborative design process that brings together not only the usual cast of characters—architects, engineers and developers—but also residents and building operators. By including the people who will live and work in the building *after* it is certified, Egger says it helps designers “think about the implications of the decisions we are making before it gets expensive.”

Because it is a green building, there might be systems that the building operator or residents haven’t encountered before. The program also makes sure there is guidance left behind for those living or working in the building “to achieve the green goals that were set in the beginning,” says Egger.

Egger shares one story about the benefits of including residents. She says five years ago dual-flush toilets were becoming more common, but in housing for seniors the two-button toilets didn’t reduce water use. The reason? The residents had no idea what the different buttons meant. “But if you install a low-flow toilet instead of one where you have to make a

decision,” advised Egger, “you are going to get less water usage.” Egger says having a collaborative design process that includes residents and building operators as early as possible can save money and insure a better-performing building.

The “Healthy Living Environment” requirement includes controlling for radon, ventilation, and lead paint, as well as providing design measures that encourage physical activity. In addition, the “Location and Neighborhood Fabric” metrics require properties be developed in areas where infrastructure already exists so “we are not increasing the development footprint,” says Egger. Further, the location should insure that residents have access to “services that they need to live a good life,” such as grocery stores, schools, and jobs.

LEED does not have a specific certification for affordable housing, but according to the U.S. Green Building Council, about a third of LEED residential projects self-identify as affordable. “USGBC does a lot of behind-the-scenes advocacy work to promote affordable housing at the national level. And when affordable housing is built, it should be green,” Asa Foss, USGBC’s director of residential technical solutions wrote BuildingGreen.

Some state housing finance agencies offer points for affordable housing that is built to LEED standards. In addition, new or renovated LEED-certified multifamily properties get lower insurance rates from the Federal Housing Administration (FHA).

The International Living Future Institute (ILFI) launched an [affordable housing initiative](#) nearly four years ago that provides education and technical assistance to affordable housing developers. ILFI essentially acts as a kind of pro bono green building consultant. ILFI is also researching the barriers for affordable housing projects to meet rigorous sustainability metrics. “We are trying to create a living future,” said Kathleen Smith, vice president of Living Building Challenge at ILFI. “If that doesn’t



Photo: Vanni Archive

*Camba Gardens in Brooklyn, New York, has 209 affordable units and is certified by Enterprise Green Communities. It was designed by Harden + Van Arnam Architects.*



Photo: Foundation Communities

*M Station is a 150-unit affordable housing community in Austin, Texas. It was built by Foundation Communities and is LEED Platinum certified.*

include everyone regardless of income, then we haven't met our goals."

So far, ILFI has worked with 11 multifamily affordable housing projects (including The Rose) that are seeking certification through the Living Building Challenge (LBC) and plans to double that number in the next year. ILFI is facilitating design charrettes and researching financing that could offset the cost of meeting LBC criteria. ILFI is also writing and distributing case studies and resources that help streamline the process of meeting LBC.

## Why Provide Affordable Housing That Is Also Green?

The U.S. is facing a housing supply and affordability crisis while government financing for affordable projects is under threat from proposed budget cuts.

But there are also optimistic trends. More states are shaping the criteria for funding to incentivize green and sustainable design. And the knowledge and commitment to design affordable housing that reduces the cost of energy, uses less-toxic building materials, and considers social connectivity is also growing.

Well designed affordable housing can do far more than provide shelter. It can strengthen financial stability for the residents, helping the most disenfranchised build healthier lives and even bolster a sense of pride.

Dana Bourland, vice president of the Environment Program at JPB Foundation, says that people who have lived in green affordable housing tell her, "Someone cares about me. I am worthy of a dignified home."

Designers and developers are cultivating both the tools and the tenacity to balance designing durable, healthy housing for the poor with the reality of tight budgets.

Architect Hilary Noll, an associate with Mithun, says sustainability and affordable housing *must* align. "I don't think you can really have a robust green building industry unless it includes everyone," says Noll.

### For more information

Preservation of Affordable Housing  
[www.poah.org/](http://www.poah.org/)

Enterprise Green Communities  
[www.enterprisecommunity.org/solutions-and-innovation/green-communities](http://www.enterprisecommunity.org/solutions-and-innovation/green-communities)

Enterprise Community Partners  
[www.enterprisecommunity.org/](http://www.enterprisecommunity.org/)

National Low Income Housing Coalition  
[nlihc.org/](http://nlihc.org/)

National Center for Healthy Housing  
[www.nchh.org/](http://www.nchh.org/)

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Jonathan Rose Companies  
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Affordable Housing and Sustainable Communities Initiative North Carolina State  
[design.ncsu.edu/ah+sc/](http://design.ncsu.edu/ah+sc/)

ILFI Affordable Housing Initiative  
[living-future.org/affordable-housing/](http://living-future.org/affordable-housing/)



### FEATURE SHORTS

## Financing Affordable Housing; Not for the Faint of Heart

**Because most of the funds are government funds, they are also subject to political pressures.**

by Nancy Eve Cohen

Getting funding for affordable housing, whether it's green or not, is competitive and complex. That's because there aren't enough funds to address the unmet need for affordable homes. In addition, funding comes from multiple sources, including government programs, which are subject to political pressures.

## Who's Who in Affordable Housing

There was time when most of the affordable housing in the U.S. was built by the government. Since the 1970s, both for-profit and non-profit developers have built and renovated most of the affordable housing.

Some of the large nonprofits build, renovate, and manage thousands of housing units. Smaller nonprofits called Community Development Corporations (CDC), which are focused locally, also build affordable projects.



Photo: BuildingGreen, Inc.

*Affordable housing projects rely on multiple funders. This sign—outside the construction site of Live 155, a mixed-income 70-unit building in Northampton, Massachusetts, and developed by the nonprofit Way Finders—lists several funders. The funding is both public and private, and comes from local, state, and federal sources.*



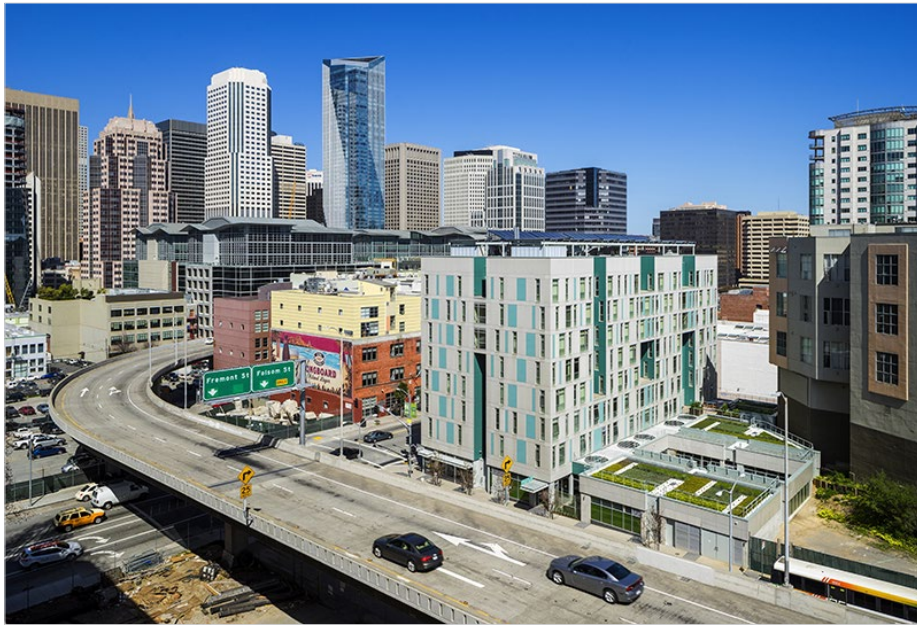


Photo: Tim Griffith

*Rene Cazenave Apartments has 120 affordable apartments, primarily for residents who were formerly homeless. The project won a Top Ten award from the American Institute of Architects' Committee on the Environment in 2016.*

Public housing authorities still own more than 1.1 million units built by the government decades ago. In recent years, they have been renovating and redeveloping that housing, often in partnership with private developers. This brings opportunities to make this older housing more green, energy efficient, and healthy for the residents.

Intermediaries, such as Local Initiatives Support Coalition (LISC), Enterprise Community Partners, and NeighborWorks America, are nonprofits that act as a kind of financing matchmaker. They secure funds for affordable housing from the government, banks, corporations, and foundations, and then provide that funding through loans, grants, and equity to affordable housing developers. Intermediaries also provide training so that affordable housing is developed more efficiently and at a lower cost.

Syndicators are entities that aggregate investors' equity and invest it in low-income housing projects. They also make sure that the housing is in compliance with the law. Enterprise Community Partners and National Equity Fund (NEF) are two of the syndicators.

Some intermediaries and syndicators make it a priority to build affordable housing that is green, sustainable, and healthy.

### **Funding to Buy, Build, and Renovate Affordable Housing**

Most of the funding for affordable housing comes from three sources:

- Equity from the sale of federal tax credits
- Mortgage debt
- Gap funding

### **Federal low-income tax credits are the primary funding source**

The Low Income Housing Tax Credit (LIHTC) program, part of the IRS code since 1986, is the key federal program supporting affordable housing in the U.S. today. From 1987 through 2016, these tax credits helped fund nearly 2.8 million affordable housing units.

The tax credits incentivize private investors to put their money into constructing, rehabilitating, and preserving affordable apartments and houses.

Unlike a mortgage, developers don't have to pay interest on the equity from tax credits, which helps keep rents low.

One of the strengths of the way the U.S. funds affordable housing is that it doesn't rely on the good will of banks or others to donate to build. The tax credits attract investment capital. Compliance laws require that the housing remain affordable for at least 30 years.

Every state gets a certain number of tax credits from the IRS, based on its population size. For example, Texas gets a lot more credits than Vermont. The state then allocates the tax credits to affordable housing projects.

Each state's housing finance agency develops its own criteria, known as a Qualified Allocation Plan (QAP), for awarding tax credits to projects. Getting tax credits is a competitive process, so developers are motivated to plan projects that meet the criteria of the state where they are building. Each QAP has to meet federal requirements, but it also has to meet the particular needs of each state.

The criteria of the QAPs can help drive the greening of affordable housing. They might include reaching a certain level of energy efficiency, or being certified by Enterprise Green Communities or by LEED.

Large banks, insurance companies, and other firms buy the credits to help lower their tax burdens and, in the case of banks, to meet their responsibilities under the Community Reinvestment Act (CRA). The CRA requires banks to make investments in the communities where they take deposits.

The tax credits for low-income housing offset an investor's tax liability dollar for dollar. If a bank, for example, purchases \$10 million worth of credits for a project, the bank will have the right to claim \$1 million in tax credits every year for ten years—as long as the project continues to comply with the affordability

restrictions the government places on it.

## Trump's tax promises have already lowered the value of the LIHTC

The value of the LIHTC is driven by the market. After President Trump was elected, just his promise to reduce corporate taxes from 35% to 15% meant “the bottom fell out of the tax credit market,” according to Sunshine Mathon, CEO of Piedmont Housing Alliance in Charlottesville, Virginia. That’s because if investors think they may not have as big a tax liability, “their appetite for buying Low Income Housing Tax Credits is also going to fall,” says Mathon.

“Based on people’s anticipation that a tax reduction might happen, there was a reduction in tax credit equity pricing of something like 10% to 15% in the market, compared to the period immediately before the election,” says Andrew Spofford, chief of staff for Preservation of Affordable Housing (POAH). “This would reduce the amount of dollars flowing into projects from the tax credit,” says Spofford. “This is all happening on top of an existing affordable housing crisis that is pretty severe,” Spofford added.

The price drop came after near historic highs for the program.

Spofford says investors walked away from two projects at POAH, causing delays while the nonprofit found other investors. And the price the investors paid for each tax credit was reduced. “It meant reducing the

scope of renovations that we can afford to do on the buildings,” says Spofford.

About half of the 35 affordable housing projects that had received tax credits from the Pennsylvania Housing Finance Agency (PHFA) were impacted after the election—some significantly. Some “had to scale down the scope of their work or restructure projects in order to be able to close the tax award,” says Holly Glauser, director of development at PHFA. The agency put \$4 million of state funding trust funds toward the projects to help make up the losses from investors.

Spofford says these changes aren’t affecting POAH’s approach to sustainable design. “Those kinds of investments in green and efficient buildings sort of make sense irrespective of the political environment... It hasn’t changed our way of approaching sustainable design, and we are continuing to double down on that strategy because it makes sense.”

But Mathon says the drop in value of a tax credit does affect “deep sustainability.”

Mathon says if a developer is struggling to raise enough funds “just to build the thing, the question of going a little deeper on sustainability or HVAC efficiency or solar or other things like that just becomes harder and harder.”

By now, nearly a year after the election, the value of the LIHTC has come back up, but it’s not as high as it was before the election, when the price was near the historic high. If investors are buying the credits for less, that means there is less capital available, making it harder to fund affordable housing development—let



Photo: PFRA + LDA

*Live 155, a mixed-income building in Northampton, Massachusetts, was funded in part by Low Income Housing Tax Credits, awarded by the Massachusetts Department of Housing and Community Development, along with funding from a number of other sources, including the city of Northampton. Way Finders, in Springfield, Massachusetts, is the nonprofit developer.*

alone projects with more ambitious sustainability goals.

“Right now, the tax credit market and corporate investors, in general, are living in a place of limbo, not knowing if anything is going to get done and how deep is it going to go,” says Mathon.

“It hasn’t been as bad as we thought it would be,” says Krista Egger of Enterprise Community Partners, “but there’s still a lot of uncertainty.”

## Fannie and Freddie and Affordability

Besides LIHTCs, affordable housing developers also need mortgages. The mortgage debt that an affordable property can support is based on its rental income minus the cost of operating and maintaining the building. If an affordable housing project is durable and energy efficient, it can provide owners with more net income, which could help them borrow more—or invest in additional affordable housing.

Affordable housing developers can obtain lower-cost mortgages from Housing Finance Agencies (HFAs) that are guaranteed by the Federal Housing Administration (FHA).

In addition to FHA, low-cost debt products are also backed by Fannie Mae and Freddie Mac, which were



Photo: Preservation of Affordable Housing

*Billings Forge Apartments in Hartford, Connecticut, is affordable housing that includes a community garden and a farmers market. It was renovated by Preservation of Affordable Housing.*





Photo: Ed Wonsek

Temple Place in Cambridge, Massachusetts, has 40 affordable units and is certified by Enterprise Green Communities. It was designed by HMFH Architects, Inc.

created by Congress. They buy mortgages from private lenders for housing projects, and then aggregate these loans into securities, which they sell to investors. What's key is that they guarantee payment, making investments less risky for investors. This reduces the rates investors demand, which reduces the interest the projects pay on their loans. The result is more affordable financing.

Fannie Mae also offers "[green financing](#)"—lower interest rates for green building certifications, and energy and water conservation in multifamily housing.

## Filling the Gap

Even after obtaining a mortgage and equity from tax credits, an affordable housing development usually still faces a funding gap. Gap financing is typically only a small part of a development's budget, but "it's a crucial last-mile type of funding source," says Spofford. "And without it you can't get to a closing, you can't build the building, and you can't provide the housing."

The gap is typically filled by loans from state and local governments

that do not have to be paid back right away. That funding comes to states from the U.S. Department of Housing and Urban Development's HOME Investment Partnerships Program, Community Development Block Grant [CDBG] program, The National Housing Trust Fund, and other programs. In addition, the U.S. Department of Agriculture (USDA) provides loans and grants to build and renovate affordable housing in rural areas. Getting these loans is a highly competitive process. Some cities, towns, and states also have their own affordable housing programs, which serve to fill the gaps in project budgets. Many of these programs require green building criteria.

## Government funding often requires affordability for decades

The gap loans bring affordability restrictions for a long time; they typically last 30 to 40 years. The tax credits also require a certain level of affordability—at least 30 years after an investment is made. Some states give incentives to keep housing affordable for 50 years—or even more. This encourages developers to build affordable projects that are both durable and energy efficient.

## Trump's budget proposal would have zeroed out some gap funding

The Trump Administration's 2018 budget proposal, released in May 2017, proposed zeroing out HUD's CDBG grants and the HOME program. "These cuts obviously would be devastating," said Spofford.

But since then, the Senate put out a bill that keeps the programs at level funding. The House appropriations bill proposed cutting CDBG and HOME by \$100 million dollars each. But recent amendments to the House bill increased CDBG funding \$10 million above the fiscal year 2017 level.

The USDA also has loan programs for affordable housing built in rural areas. The president's 2018 budget called for eliminating most of the USDA housing programs and reducing rural rental-assistance funds. The Senate bill mostly retains the USDA funding at 2017 levels, while the House would make smaller cuts. Both the House and Senate bills would reduce USDA-funded rental assistance.

With the budget unsettled, Congress has passed a continuing resolution allowing the government to function at essentially the same funding levels as fiscal year 2017 until early December.

Laurel Blatchford, senior vice president and chief program officer for Enterprise Community Partners, says she has not seen a concrete impact yet on the development of green, affordable housing. "It's trench warfare, not nuclear annihilation," said Blatchford about the fight to keep housing programs funded. She says Enterprise, a bipartisan organization, is continuing to make the case to members of Congress that these programs are critical to their communities.



## How Six Affordable Housing Projects Got to Green

Stories of designers and developers who overcame the challenges of building affordable housing that is also green, sustainable, and healthy.

by Nancy Eve Cohen

Over the past fifteen years, an emerging trend in affordable housing is better and better design. “The most thoughtful, private non-profit developers out there have been paying attention both to ‘green’ and the quality of how the building looks and sits on the site,” says Sunshine Mathon, who served for the past decade as the development and design director at Foundation Communities in Austin, Texas.

Mathon, who is now the CEO of Piedmont Housing Alliance in Charlottesville, Virginia, helped manage and design the construction of nearly one thousand sustainable and healthy apartments for low-income individuals and families in Texas. “The people who don’t live there drive by and never know it is affordable housing,” says Mathon. And the people who do live there “have a sense of pride when they come home.”

But building *affordable* projects that instill pride, protect the environment, and promote health is challenging.



Photo: Foundation Communities

*M Station is a 150-unit affordable housing community in Austin, Texas. It was built by Foundation Communities and is LEED Platinum certified. Sunshine Mathon, who served as the development and design director for Foundation Communities, developed M Station.*

Architects and developers who spoke with BuildingGreen described their strategies for finding design solutions that addressed the needs of people and the planet while also meeting price limitations.

### **Orchard Gardens Sunnyvale, California and Curtner Studios San Jose, California—Renovations**

#### **OJK Architecture + Planning, First Community Housing**

When architect Hilary Noll visited residents nearly two years ago in Orchard Gardens, an apartment building in Sunnyvale, California, she learned that tenants on the first floor didn’t feel safe leaving their windows open. The building has no air conditioning and relies on outdoor air for ventilation. The result for these residents was poor indoor air quality and the risk of mold.

At the time, Noll was an Enterprise Rose Architectural Fellow with First Community Housing, a nonprofit housing developer that designs, develops, and manages affordable housing. Orchard Gardens is a 62-unit low-income housing project for families who earn between 30% and 60% of the Area Median Income (AMI).

The closed windows posed “a threat to human health and overall wellness,” recalls Noll. That’s because mold could trigger asthma and other upper respiratory illnesses.

First Community changed all of the windows in the building, and Noll, working with a window manufacturer, came up with a special design for the first floor that integrated three kinds of windows and a ventilator. Whether or not the windows are open, a small



Photo: Hilary Noll

*Windows at Orchard Gardens, a 62-unit affordable housing project for low-income households. During renovations, the nonprofit First Community Housing, redesigned the windows on the first floor to increase ventilation and security.*

ventilator—one inch by 18 inches—slides open as a secure pass-through for air. In addition, Noll added two continuous, variable-rate fans in the kitchen and bathroom that pull in fresh air. The window design includes a limiter, a locking mechanism for added security.

When Noll visited months afterwards, nearly every window was open even when residents weren’t home. “They were so happy and so proud of their new windows and having something that gave them control over their environment,” says Noll. She remembers “a really sweet moment” when a little girl proudly told her she could open the windows herself, with the easy-to-use ADA-approved crank handle.

When planning renovations for another building owned by First Community Housing, Noll also put the health of the residents, along with transportation, job training, and social connectivity, at the top of her list.

Curtner Studios in San Jose, California is a 179-unit building for people earning between 30% and 60% of AMI or less, many of whom used to be homeless. Very few have cars, and some of the parking spots in the indoor garage sat empty. When figuring out what to do with the space, First Community held a design charrette that included the residents.



The result was more secure space to store and repair bicycles. First Community also partnered with a group that is training residents to become certified bicycle mechanics. “It built a sense of purpose and activity for a lot of folks who were unemployed or underemployed... and it was all around bicycles,” says Noll. “It sounds really simple and trite, but it created so much purpose and pride at the property.”

**Live 155, Northampton, Massachusetts—  
47 Affordable and  
23 Market Rate Units**

**Peter Frothingham Registered Architect, LDa Architecture & Interiors, LLP**

There was a time when rooming houses—single-room-occupancy (SRO) buildings that rented rooms by the week or the month—were common. They provided a room, shared bath, and kitchen for single working people as well as those down on their luck.

Seventy-year-old Bradford Ward lived in Northampton Lodging, an SRO in Northampton, Massachusetts, for seven years. “You had to make it home. You had to make it your own little comfortable world,” says Ward. He cooked his meals in his room using a toaster oven, electric skillet, microwave, and a little grill. There

was a shared bathroom and kitchen. Ward says he kept to himself and took his showers between 2 a.m. and 5 a.m. “when other people were sleeping.”

Ward liked the location, right on the bus line, across from the train station, next to a bike path, and not far from a grocery store. For the most part, it felt safe and comfortable, but there was one problem: ventilation. When the furnace came on, Ward says he could smell the fuel burning. He would quickly put a fan in the window at the end of the shared hallway “to try to get a clean breath.”

Northampton Lodging was knocked down last year to make way for Live 155, a new 70-unit energy-efficient all-electric building, with photovoltaic (PV) panels on the roof that are projected to cover a third of the energy use. Forty-seven of the units will be affordable efficiencies and one-bedroom apartments. Eighteen of the units are reserved for households earning less than 30% of AMI. Way Finders, the nonprofit developer, moved former tenants into temporary apartments. Tenants who remain in good standing will be offered a unit at Live 155. Ward says he’s watching the construction on the new building, and he likes what he sees.

Doug Dick, of LDa Architecture & Interiors, the principal in charge of Live 155, says he and his colleagues are “trying to push the building to do better, and be better for the people who live there,” making it as energy-efficient, healthy, and livable as the budget will allow. That requires tradeoffs.

“A small unit needs light,” says Dick, standing in one of the 455 ft<sup>2</sup> efficiencies that are under construction. He gestured toward the 55 ft<sup>2</sup> set of three triple-glazed windows. “These are big windows... a lot of glass,” he says. The windows not only provide light and a view from the small apartments, they reduce the amount of heat loss compared to the double-glazed windows the design team had first chosen. After a lot of research, the designers found a Canadian window manufacturer that



Photos: Way Finders (top); PFRA + LDA (bottom)

*Northampton Lodging (top), which rented out rooms by the week and the month, has been demolished and is being replaced by Live 155 (bottom). Live 155 will be a 70-unit building in Northampton, Massachusetts, that includes 47 affordable efficiency and one-bedroom apartments with supportive services. It is designed by Peter Frothingham Registered Architect and LDa Architecture & Interiors.*

sold a triple-glazed window at a cost that was not substantially higher than the original one. This design choice and others made the building more energy-efficient.

The designers also invested in the building envelope, upgrading the sheathing from basic oriented-strand board (OSB) to exterior plywood, and covering it with a self-adhering membrane (Blue Skin) as a weather-resistive barrier (WRB)/air barrier. Wrapping the entire exterior wall assembly in rigid foam eliminates most “of the thermal bridging that typically happens with a wood frame building,” says Dick. “It’s just a little more expensive, and we had to find space in the budget to do it.”

Dick says they cut dozens of line items to find savings for the windows and envelope, and other upgrades. They shrank the unit sizes (by 6” of width each) and removed common space, saving about 5,000 ft<sup>2</sup>. That was a tough decision, says Dick, “because these are small units, and there’s some desire to have common space where people can gather.” Instead,



Photo: BuildingGreen, Inc.

*Doug Dick, of LDa Architecture & Interiors, is the principal in charge of Live 155, a mixed-income building in Northampton, Massachusetts. The designers chose large triple-glazed windows to reduce heat loss and provide light for the small efficiency and one-bedroom apartments.*



Photo: BuildingGreen, Inc.

*The designers of Live 155, a 70-unit building with 47 affordable units in Northampton, Massachusetts, invested in the building envelope using exterior plywood, a self-adhering membrane, and rigid foam to make it as energy efficient as possible.*

they reconfigured the space around the elevator for people to gather. They also cut back on plantings, paving, and the cost of interior finishes (but still have low-VOC paints). The designers also cut costs by having one elevator instead of two. Instead they added a third staircase, located in the main lobby of the building, next to the elevator, with windows on every landing. The idea is residents will be encouraged to walk more, “if they have a nice, sunny, interesting stair,” says Dick.

The upfront cost-adding features would reduce operating costs over time—and create a more durable building. That appeals to the nonprofit developer, Peter Serafino of Way Finders, which plans to own the building for more than 15 years. “I am willing to invest in the building envelope and building systems, including energy systems, that are going to help reduce the operating costs over the life cycle of this building,” says Serafino.

Another feature might resonate with former Northampton Lodging resident Ward. Each unit has its own energy-recovery ventilator, controlling moisture, bringing in fresh air, and keeping the rooms from getting dank and stuffy, even in the winter. Ward says he’s seriously considering moving into the new building. “I like the idea of it being green,” he said.

## **The Rose Apartments— Minneapolis, Minnesota**

### **MSR Design**

In 2013, MSR Design in Minneapolis began work on a mixed-income, 90-unit building in Minneapolis called The Rose, an “ultra-sustainable building,” according to the developer’s website. It has 47 affordable dwelling units and 43 at market rate. The design reduced energy use by 72% over baseline, reduced potable water use by 50%, and captured 90% of the stormwater and treated it on site.

Paul Mellblom, a principal at MSR Design, says designing buildings that are both affordable and sustainable is an opportunity to figure out “how to do things better with less. That is not to say that you should lower your standards. It causes you to rethink.”

Mellblom and his team set a high standard when they designed The Rose: a building with an energy use intensity (EUI) of 30 kBtu/ft<sup>2</sup>•yr—and there was a lot to ‘rethink.’

First, the building was in Minnesota, where it’s cold much of the year. The entrance ramp to the underground parking for The Rose was initially short and steep, and often shaded. That required a costly snow-melt system that ate up a lot of energy. “Just for this tiny little ramp, to keep it heated so your car doesn’t skid down... it would have been 6 EUI of the 30,” recalls Gina Ciganik, who was vice president of Aeon’s Housing Development Team. The Rose was developed by Aeon and Hope Community.

The design team hunkered down and came up with a solution: incorporate the ramp into an existing surface parking lot and give it a long, slow slope that didn’t need a snow-melt system. It also freed up green space, which became part

of a community garden. “In a tight, urban space, it helped provide some green relief for the residents,” says Mellblom.

The designers took the money from the snow-melt system and applied it elsewhere to make the project better. Mellblom says their approach to design is that “there are a lot of agendas to meet, and one of them obviously is to be cost-conscious and the other is to try to be as sustainable as possible.”

The design team also sought the sweet spot between cost, and heat loss and gain through the envelope, including windows. They came up with a different design decision than the architects at Live 155.

“Everyone says you need triple-glazed windows, which are so over-the-top expensive,” says Ciganik. That’s true, if you’re thinking about a single-family house that has a lot of envelope for the volume that it is enclosing. But most apartments have only one exterior wall. “So your loss or gain, depending on whether it is a heating or a cooling season, is limited to one wall,” explains William Weber, a senior research fellow at the Center for Sustainable Building Research at the University of Minnesota. Weber, who consulted on The Rose, says energy modeling on different kinds of windows showed that as the windows got more and more efficient, the cost skyrocketed. “There was really a diminishing benefit,” said Weber. Finally, the designers settled on a



Photo © Don F. Wong

*The Rose Apartments in Minneapolis, Minnesota, is a mixed-income 90-unit building designed by MSR Design.*



double-glazed low-e window. The difference between that window and the triple-glazed was substantial. “It was a big chunk of money that could be more effectively spent on upgrades in other parts of the building. So really, it was a tradeoff,” says Weber.

Extra philanthropic funds were raised to make The Rose as healthy, green, and sustainable as possible. The funding was donated based on the idea that lessons learned from The Rose would be shared with others.

## **Rene Cazenave Apartments, San Francisco, California—120 Supported Units, Mostly Studios**

**Leddy Maytum Stacy Architects,  
Saida + Sullivan Design Partners**

Architect Vanna Whitney says everyone deserves good design. By design she doesn’t mean just aesthetics, but also the environmental and social impact of a building.

When Whitney, a senior associate at Leddy Maytum Stacy, began designing Rene Cazenave Apartments in San Francisco, a big priority was making sure the residents didn’t hole up in their apartments, isolating themselves. That’s because many were formerly homeless people and were just coming off the street.

Whitney honed the design to increase interaction between residents, as well as between residents and the supportive services that would be offered in the building.

The services included job training, social workers, and a psychiatrist. Whitney says these would typically get pushed into the back of the building. But she put them in the center.

Whitney placed the residential entryway at one point and put the elevator at another, and between the two she “created a special heart in the building ... where people will pass through every single day.” That 12-foot-wide corridor, dubbed “Main Street,” is flanked on one side by social services and on another by a courtyard. Residents entering the building have to pass by the services, the courtyard, the benches, the tenant lounge, and the laundry—all increasing the chance that people would interact. “Just to see and be seen would help,” Whitney says.

On the upper floors, the entries to the units are clustered in groups of four, creating little neighborhoods, encouraging more socializing.

Whitney says design elements that

support residents’ health and wellness, including mental health, is “mission critical” and part of building green. She also says improving health makes the building more sustainable. The more likely residents are to need fewer services in the future, the more likely they are to move out of supportive affordable housing—freeing up the unit for someone else in need. “So it reaches a wider audience,” says



Photo: Patrik Argast

*The architect, Vanna Whitney, of Leddy Maytum Stacy, chose a wood grille ceiling and colored benches for the main corridor of the Rene Cazenave Apartments to make it warm and inviting, but also limited the use of more costly materials to meet the budget constraints.*

Whitney, “with the same amount of money ... you create one thing and have it stretch further.”

But there were budgetary constraints. Whitney met them, in part, by limiting more costly materials.

Whitney chose a wood grille for the ceiling above “Main Street” and vibrantly colored benches “to make it warm and inviting, but also limiting that material to a distinct area to limit the cost.”

Exterior cladding is always a significant part of the budget. “We picked a moderately priced panel, a grey panel to be the primary finish to the building, and then we picked a more expensive panel—an accent turquoise panel—and limited the amount of it, because it is more expensive.”

The building is topped with a solar canopy with both solar hot water and PV, which offsets the energy bill for common areas of the building.

Over time, Whitney says the building brings a return on the investment, making it sustainable. “You not only lower the utility bills of the residents who may be on fixed incomes, but you are also trying to lower the long-term operating costs of your client who is managing the building.”

The Rene Cazenave Apartments won a Top Ten award from the American Institute of Architects’ Committee on the Environment in 2016.

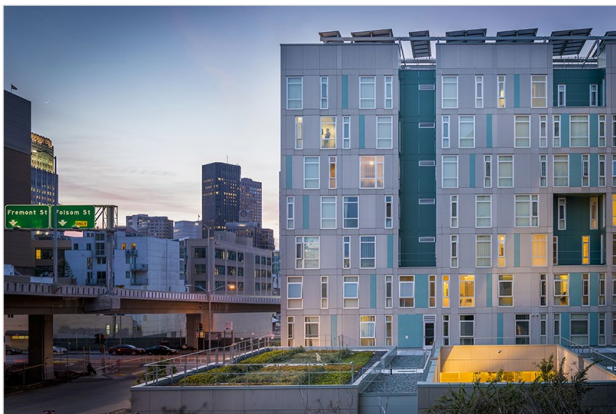


Photo: Patrik Argast

*Rene Cazenave Apartments has 120 apartments, primarily for residents who were formerly homeless. The designers chose a moderately priced grey panel for the primary finish to the building, and fewer, more costly turquoise panels, in order to keep within the budget for this affordable project.*

## Melpet Farm Residences, Dennis, Massachusetts— 27 Affordable Units, Pursuing Net Zero

**Brown Lindquist Fenuccio & Raber  
Architects, Inc.**

“When people hear the term ‘net zero’ they just see dollar signs.”

That’s the assessment of Julie Klump, vice president of design and building performance for the nonprofit developer Preservation of Affordable Housing. Klump wanted to show that net-zero-energy buildings *can* be built affordably because “that’s how we should be building buildings ... and low-income residents deserve a shot at a building with low utility bills.”

In 2015, Klump led a team that designed and built a nine-building, 27-unit, affordable housing project on Cape Cod, Massachusetts, for households living at or below 60% of AMI. A quarter of the apartments were for people on the brink of homelessness. The goal was to build housing that is both affordable and net-zero.

The project overcame some of the cost challenges by securing separate funding for the solar PV and by arranging for the land to be donated.

The project faced another challenge. Most of the subcontractors had never built a net-zero building. So Klump arranged for them to meet with a



Photo: Preservation of Affordable Housing

*Melpet Farm Residences in Dennis, Massachusetts, has 27 affordable units for people on the brink of homelessness. The nine-building project was developed by Preservation of Affordable Housing.*

consultant with that experience, Marc Rosenbaum, P.E.

The plan was “to walk through every detail to make sure they know where the sealing joints went, where flashing went, so when we built this building, and tested it for airtightness and thermal performance that we would hit our goals,” says Klump.

The building enclosure, roof, exterior walls, and slab were designed to be airtight. The units would be airtight between each other. Klump says that’s really important “in a multifamily building because it is the only way you can control odors and humidity going from unit to unit. It also helps the sound.”

At first, she expected resistance, or even cavalier attitudes from subcontractors with decades of experience. But instead, Klump says, “they came in completely open-minded and receptive to discussing the details ... in order to hit the owner’s targets.”

The subcontractors came up with ideas of their own, Klump recalls: “Let’s do a mockup. Let’s change the sequence of how we are building this. Let’s do the blower door tests on a small corner of this building and let’s see how it works.”

The chance to learn cutting-edge techniques was a motivator. “They knew they would walk away having learned something new and valuable,” says Klump, that they could “advertise they were able to accomplish or be able to give their clients better buildings.”

The development is now fully occupied, and the owners are analyzing heating and cooling usage data to determine if it is functioning as net-zero.

“The goal was to try to show on a per unit basis ... this could be done,” says Klump, “and that other affordable housing developers can do this.”



## NEWS ANALYSIS

### Washington, D.C. First to Achieve LEED at Citywide Scale

**The city is first to earn a Platinum LEED for Cities certification, leveraging information technology to track progress toward a range of sustainability goals.**

by James Wilson

At least 55 cities and communities around the world have signed on to test the [LEED for Cities pilot](#), and Washington, D.C. has achieved the first certification in the new system—a Platinum rating.

Cities seeking certification submit performance data for a range of sustainability categories—Energy, Water, Waste, Transportation, and Human Experience—to receive a base score. Up to ten additional points can be earned by certifying individual projects within the city and by creating action plans for specific goals like carbon reduction, climate resilience, and green infrastructure.

The emphasis is on using data to drive continuous improvement through a holistic approach to ongoing sustainability efforts. Washington, a leader in the use of “smart city” tools, could serve as a model for [how cities can lead on climate change](#) in a world that is rapidly urbanizing.

### Keeping up by scaling up

The vision of the U.S. Green Building Council (USGBC) is that, within a generation, all people should be able to live, work, and learn in a green building or community. According to the organization, one impetus for developing the LEED for Cities system was the recognition that efforts focused on individual building projects are not sufficient in such a rapidly urbanizing world.

“The building-by-building rating strategy for accomplishing our global mission was not aligned with





Photo: Carol M. Highsmith

Washington, D.C.'s "smart city" technology and holistic sustainability strategy plan helped it earn the first LEED for Cities Platinum certification.

the ferocious speed of urbanization globally," says Roger Platt, senior vice president of strategic planning, USGBC. He told BuildingGreen that there has been a big push from hyper-urbanizing places like China and India for a tool that could be applied to entire cities or districts "so that the scale would be more aligned with the reality of what they're actually trying to accomplish."

In addition to the need to address sustainability at the urban and infrastructure scale, also driving development of LEED for Cities is USGBC's increasing emphasis on performance. Platt explained that the goal is to move toward an integration of the aspirational design component—represented by the traditional, strategy-based LEED for buildings systems—with the actual operational performance of the building.

According to Platt, there will eventually be a performance-only version of all other LEED rating systems. To earn certification, teams will enter performance data into [the Arc platform](#) to demonstrate that their projects are operating at the required levels.

There is an increasing shift toward the idea that, as Platt put it, "a green building is only a green building if it's

performing now as a green building." He says that all too often, buildings built with tremendous aspirations to be high-performing don't perform well "unless there's additional incentive to make sure people are making them perform well."

### Transforming cities with the power of data

The way to keep the focus on performance is with data, says Jay Wilson, a green building program analyst with Washington, D.C.'s Department of Energy & Environment. Wilson, who was involved in preparing Washington's LEED for Cities application, told BuildingGreen that their mantra has been that you can't manage what you don't measure—a common refrain in the sustainable design community.

This is illustrated in that Washington was the first city in the country to pass a benchmarking law requiring public and private buildings to track and report energy and water performance data. The data show that the district's efficiency and improvement projects have resulted in 3% reductions in electricity use per year.

LEED for Cities is structured around this concept of gathering information to inform goals and action. A city

pursuing certification in the new system would follow this basic process:

1. Set specific, measurable goals for increasing the city's sustainability across a range of categories.
2. Develop action plans for meeting those goals.
3. Track performance regularly.
4. Adjust strategies accordingly to further improve performance.

Projects are required to track 14 different data points across the five categories. Performance in the Water category, for example, is measured by domestic water consumption, and performance in the Transportation category is measured by "distance traveled in individual vehicles daily."

Because the quality of the metrics used is crucial to the effectiveness of this process, USGBC consulted the U.S. Department of Energy's National Labs and programs like [C40 Cities](#) and [International Ecocity Standards](#) to determine what to include.

Platt explains that the metrics included are ones that a majority of municipalities around the world already had access to or were tracking. For example, the metric used to measure performance in the energy category is greenhouse gas emissions expressed as tons per person per year.

### Chief technology officer as champion

The LEED for Cities process, managed via the Arc platform, seems to be tailored for easy adoption by places like Washington that are already using data and sensing tools to gather information about city systems and infrastructure. Wilson told BuildingGreen, "For the District, we are looking at all those indicators, and through our [Smart Cities platform](#), our chief technology officer was hugely integral to the application process and achieving the certification."

"CTOs are often the biggest advocates for LEED for Cities," says Platt,

explaining that they are often the ones who go to the mayor with all the data that's been collected to make the case that certain city programs have been effective and will continue to improve performance.

In addition to Smart Cities, Washington also has its [Sustainable DC Plan](#), which includes specific sustainability goals for a range of categories, including buildings, transportation, and economy.

"It's very much a holistic view of what a sustainable city could be," says Wilson, who explained that the plan provided the framework for the achievements that were then rated by the LEED for Cities platform. "We thought it was a great opportunity to package what we've already been doing and showcase our successes."

Unveiled in 2012 after 18 months of research and development, this plan might shed some light on how Washington was able to achieve a Platinum rating and thus serve as an effective model for other cities to study.

## Evaluating policies

Most would agree that putting in place the right policies is important—and that the only way to identify the right policies is by collecting performance data. Platt says there is debate over how to reward cities that are doing a lot in terms of adopting new policies, which can require political courage and risk. Should these cities have to wait until these policies affect performance before earning points for them?

"A lot of places want credit for policies, but this is a performance-based system so we're struggling to figure out if there are some policies that are so critical to success over time in accomplishing certain goals," says Platt. He gives the example of a land use policy that preserves access to open space. If you wait too long to enact certain policies you may never be able to.



Image: Arc Skoru Inc.

*The Arc platform is used to collect, organize, and communicate the performance data from a range of sustainability categories used to score LEED for Cities projects.*

## Does it meet the intent?

According to Platt, a bonus of performance-based rating systems like LEED for Cities is that each project can choose its own strategies for meeting sustainability goals, allowing for maximum flexibility of use.

Platt explains that once the pilot stage of LEED for Cities is complete and there is consensus about what the system's goals should be, participants can then pursue their own strategies for meeting those goals. What matters is that "their strategies actually result in as great or greater a level of performance than what's been associated with the traditional LEED rating systems where we're giving people points for doing the specific strategies we recommend."

## Integration: using data to understand urban ecology

As cities accumulate more and more performance data, not only will they be able to analyze the effectiveness of their different chosen strategies, they'll also be able to identify relationships between them. A robust enough dataset might indicate, for example, that one initiative to reduce waste is either reinforcing or conflicting with a separate strategy.

Wilson notes how the traditional LEED systems are most successful when looked at holistically so that you can see synergies between systems.

He says he hopes that as the LEED for Cities system and Arc platform continue to be developed, that the city will be able to use them to integrate different data points. "So depending on how it develops, we can see how if you reduce water, you're reducing energy as well because of that [energy-water nexus](#)."

In terms of how the LEED for Cities system will continue to evolve, Platt says it's all about developing the most appropriate data points through discussion of whether certain metrics are misleading

or are effectively representative of progress in a city's performance.

Platt explains that as more places participate in LEED for Cities and its database becomes more integrated, its impact may expand beyond operations to affect the design and planning of cities.

"I think it will be a natural evolution that when we have a database that is robust with data from actual high-performing cities—that cities may ask, 'What is it about this building you're building that is advancing the same goals that we've been getting all this recognition for?'" says Platt. In this way, LEED for Cities could also reinforce improved performance at the building scale, leading to individual projects that are more appropriate to their site and the infrastructure of the city they're situated in.

## Rigorous enough?

If the LEED for Cities pilot is successful, the system will proceed through the same review process and comment period that all other LEED systems went through. One critique that may be voiced is that the system should be more rigorous in order to really drive change and improvement. This might be achieved, for example, by setting more progressive benchmarks against which performance scores are calculated, or by setting more advanced pre-certification requirements.



For now, cities like Washington that are ahead of the game might see LEED for Cities as more of a pat on the back than a tool supporting transformational change. As Wilson put it, “I think that it’s one tool in our chest. LEED for Cities provides a great opportunity for us to tell the story and to start measuring our progress so that we can compare ourselves to other cities, but we also are just going to move forward, making progress on our own as well.”

### For more information

USGBC  
[usgbc.org/cityperformance](http://usgbc.org/cityperformance)



### NEWSBRIEFS

## Analyze a Neighborhood with the Touch of a Button

**Opportunity360 scores neighborhoods on health, affordability, transportation, and more.**

by Paula Melton

Want to know what a neighborhood offers before you even get a chance to visit? With a new tool called Opportunity360, you can punch in an address and get an in-depth profile of the surrounding neighborhood, including:

- Housing stability (metrics like affordability and home ownership)
- Education (high school and college completion)
- Health and wellbeing (life expectancy, access to healthcare, etc.)
- Economic security (income levels, poverty, and employment)
- Mobility (access to transportation)

A project of affordable housing developer Enterprise Community Partners, the program is designed to help anyone with a stake in a neighborhood—from nonprofits, to government agencies, to developers



Image: Enterprise Community Partners

This graphic shows the five aspects of opportunity scored by the Opportunity360 software.

and architects—identify stronger and weaker areas of opportunity for residents. By “opportunity,” the group means affordable access to housing, education, healthcare, employment, and transportation.

Given an address, the tool produces an “opportunity scorecard” covering these five basic indicators of opportunity, and comparing them to state and regional averages. A 20-plus-page “opportunity measurement report” provides a complete breakdown and narrative for each score.

“Design can play a pivotal role” in improving opportunity, according to Vrunda Vaghela, director at Enterprise Community Partners. “Opportunity360 provides a road map to understanding the factors driving a community’s potential to thrive, supporting practitioners in understanding the full context of a place so that they can be better informed to make smarter, more thoughtful design decisions.”

For example, project teams could identify a site for affordable housing by searching for neighborhoods with a strong need for it. Or if a site is already chosen, the team may discover a lack of affordable healthcare access and find ways to provide that within the building program.

To rate a neighborhood, Opportunity360 draws from a large number of public and proprietary

databases. These include software tools that may already be familiar to building professionals, such as Walk Score, Streetwyze, and Boxwood Means, as well as data sources managed by federal government agencies.

Users can access the tool at: [www.enterprisecommunity.org/opportunity360](http://www.enterprisecommunity.org/opportunity360).



## Zero Waste? Is It TRUE?

**The TRUE rating system helps businesses and facilities eliminate waste through education and performance tracking.**

by James Wilson

The rebranded TRUE (“Total Resource Use and Efficiency”) Zero Waste rating system (administered previously by the U.S. Zero Waste Business Council) was recently launched by Green Business Certification Inc. (GBCI) as a way to promote a holistic approach to waste reduction.

The [TRUE Zero Waste rating system](#) is meant to encourage and facilitate the green business practice of waste reduction. A company that uses its resources more efficiently and generates less waste is not only reducing its environmental impacts, but also saving money.

The certification is available for any facility, whether it’s a manufacturing plant, an office, school, or public



Photo: Sierra Nevada Brewing Co.

Sierra Nevada’s brewery in Chico, California, has achieved a Platinum TRUE certification. Among other things, the facility uses a HotRot composting system to convert all food waste into a nutrient rich amendment for onsite agriculture, and makes biodiesel with used fryer oil from the restaurant.

building like a museum or library. Companies that have certified Q under the program include Tesla, Sierra Nevada Brewing Co., and Cintas.

By helping organizations understand the flow of material through their processes and operations, TRUE is a tool for identifying opportunities for reduced material use, reuse, and recycling.

The program emphasizes education and performance tracking, and goes beyond waste diversion to include upstream policies and practices as strategies for eliminating waste and redesigning product life cycles.

To earn certification, a facility must divert an average of at least 90% of waste over a 12-month period. This is measured against data collected over an initial, base year of operation, and waste diversion data must be submitted annually to maintain the certification.

In addition to sharing diversion data with GBCI, projects must also provide a case study of zero-waste initiatives to be [published on the TRUE website](#).

As part of the initial certification process, an assessor will conduct an onsite review of the facility to verify all requirements have been met.

There are currently at least 88 TRUE-certified facilities worldwide.

## For more information

TRUE  
[true.gbci.org](http://true.gbci.org)



## To Save Cities, Save Trees

**Urban forests do \$500 million worth of heavy lifting each year for the world's largest cities—and there's plenty of room to plant more.**

by Paula Melton

Dr. Seuss's Lorax spoke for the trees, but you don't have to be a fantastical creature out of a children's book to do that anymore. A new [study](#)

published in *Ecological Modeling* suggests that urban forests play a vital economic role in very large cities, and they could be doing even more.

According to the researchers, urban trees are known to:

- Remove air pollution
- Manage stormwater runoff
- Reduce heating and cooling costs in buildings
- Sequester carbon

The scientists put a dollar amount on each of these natural functions that benefit humans, also known as *ecosystem services*. Their goal? Provide a baseline that can be used strategically to increase conservation efforts in megacities worldwide, including London, Los Angeles, Cairo, Tokyo, and others. (A megacity has a population of more than ten million.)

Unlike in smaller cities, estimating tree cover in megacities is quite difficult and expensive when using on-the-ground surveys, according to the paper, so the scientists had to develop a way to do it using computer modeling. The models account for the costs of managing trees.

The total annual value of tree cover in each megacity averaged more than \$500 million. Air pollution reduction was the most prominent benefit. Overall, researchers found that urban trees provide nearly \$1 million in these services per square kilometer per year. Urban forests also provide \$20,000/km<sup>2</sup> of stormwater processing, \$820/km<sup>2</sup> in reduced heating and cooling expenses, and \$17,000/km<sup>2</sup> in carbon sequestration services.

Perhaps the best news of all: according to modeled projections, the average megacity has space to increase its urban tree cover by 85%, which would increase all these benefits by a similar amount.



Photo: Fons Heijnsbroek. License: Public domain.

*Urban trees offer more than just shade. A new study looks at their considerable economic value to megacities.*

## More about trees

[Primer: Ecosystem Services](#)

[Tree-Covered Neighborhoods Pop Out Healthier Babies](#)

[Kids Breathe Easier When Trees Eat Smog](#)

[Urban Trees Curb Shady Behavior](#)

## For more information

Ecological Modeling, Volume 360, 24 September 2017, Pages 328–335  
[sciencedirect.com](http://sciencedirect.com)



## PRODUCT REVIEW

### Glass Façade with Vacuum Insulation

**Sedak's Isomax system incorporates vacuum insulated panels into insulated glazing units to create thin glass façades with improved thermal performance.**

by Brent Ehrlich

All-glass façades are rarely all glass; they are just made to look that way. The transparent window portion of the façade, or insulated glazing unit (IGU), is installed in a curtainwall along with opaque spandrel sections that hide columns, beams, and mechanicals from view. Cladding,





Photo: Sedak GmbH & Co.

*With a maximum R-value of more than 24 for the opaque sections, a U-value of 0.12 for the transparent portion, and printing and dyeing options for both interior and exterior surfaces, Isomax is an a truly “all-glass” façade with solid thermal performance.*

## Why use vacuum insulated panels?

Triple-pane IGUs with low-e Q and argon fill have center-of-glass U-values of about 0.20, which converts to an R-value of 5—less than the equivalent of one inch of polyiso insulation. To raise the thermal performance of the entire wall assembly requires insulating the opaque spandrel sections, and there is no better insulation than a VIP. Functioning similarly to a glass thermos bottle, the VIPs used in curtainwalls typically have an R-value of about 28 per inch, the equivalent of seven or more inches of mineral wool, adding impressive R-values without the bulk. But if it gets punctured and loses its vacuum, it also loses most of that insulating ability.

According to the company, a mockup of Sedak’s Isomax has a maximum R-value of more than 24 for the opaque sections and a U-value of 0.12 for the transparent portion.

## Automation and a new product category

Using VIPs in curtainwalls is not new (more on this later), but installing them into large IGUs under automated, factory-controlled conditions is. According to Maic Pannwitz, vice president at Sedak, “We have the largest insulating glass line in the world.” This capability allows the company to make Isomax in sizes up to 10.5’ x 49’, which is very large for an IGU, let alone one containing VIPs.

The factory’s robotics can create the transparent portion of the triple-pane

IGU anywhere within a panel using Warm Edge Technology spacers that act as a thermal break between the glass. These spacers have to be placed within one-tenth of an inch tolerance hundreds of times per job, something that cannot be done accurately by hand, Pannwitz says. Custom-made VIPs from va-Q-tec are added before the third pane goes on, followed by the outer panel, and it all has to match exactly onto the frame.

Quality control carries over to the VIPs, where the vacuum is monitored via computer chip to ensure it has not been damaged before the final pane of glass is assembled (the vacuum can also be checked after installation). That glass then protects the VIP from accidental puncture, such as when nails are driven into standard curtainwall spandrels.

For the opaque sections, Sedak uses UV- and scratch-resistant inks for the interior and exterior of Isomax, and can create images and textures using digital printing to maximize design and color options.

## Refining a promising technology

Isomax can be used in new construction, but it is thin enough to fit into other façade systems, so it could be a viable alternative to add insulation to a retrofit project. Though it is new to the market and has not been installed on any projects yet, so there is no real-world feedback, VIPs have been used in curtainwalls before.

Perkins+Will was the first to do so, installing them in a retrofit project at the University of Alaska–Fairbanks in 2014. According to architect Carsten Stinn, senior associate at Perkins+Will, “We thought getting daylight into the space was paramount,” but when temperatures hover at –45°F, sitting next to standard double-pane windows was untenable. To maintain the views and daylighting, they partnered with Dow Corning and the university to incorporate VIPs into the spandrel glass portion of ten IGUs as a test case. The final product was a custom panel with 1.3 inches of VIP in the opaque portion, providing

sometimes glass, covers the spandrel to meld with the building’s design.

These spandrel sections have to be carefully engineered, insulated, and detailed to integrate the IGUs and reduce potential thermal bridging, and moisture and air infiltration. This requires materials for the aluminum framing, trim, and cladding; and added time and labor for design and installation. But what if you didn’t have to build and insulate spandrel sections and truly made the façade “all-glass”?

Isomax, from the German manufacturer Sedak, is aiming to do just that. Using [vacuum-insulated panels](#) (VIPs) installed in the opaque sections of an all-in-one IGU/glass façade, Isomax can achieve an average R-value across a panel greater than 15 in an all-in-one panel that is only two inches thick.

R-40 in those sections and R-4.8 in the triple-pane IGU itself.

Though Stinn says the project was a success, it was not all smooth sailing. Stinn says, “The size of the glass and the size of the vacuum panels didn’t align,” resulting in incomplete seals along some edges. They solved the problem using [silica aerogel](#), another innovative insulation technology. He claims that the glazing company that created the panels tried to re-create the VIP curtainwalls on another job without success.

Pannwitz says Sedak’s manufacturing process allows them to integrate the transparent and opaque portions of a glass curtainwall without these problems.

### Cost and Isomax’s future

Putting a cost on Isomax is difficult since they are custom manufactured and require special shipping from Germany, but the price starts roughly at \$85 per square foot for the panels. Even at a high cost, after looking at the schematics, Stinn is intrigued by the system’s possibilities. He noted that the thin profile could add square footage to a building, which would be well worth the higher system costs where real estate prices are at a premium. He says Isomax also becomes more viable on a developer project because you are only dealing with one system; installation would be much faster, with fewer materials, less labor, and potentially lower overall costs. Basically, having the spandrel part in one IGU is “brilliant,” according to Stinn.

Brilliant or not, new products like Isomax often face an uncertain future in the U.S. With high first costs and no comparisons on the market, architects might find it difficult to specify them on some jobs, but energy-conscious architects willing to take a risk might just find a way to finally like an all-glass building.

### For more information

Sedak GmbH & Co.  
[www.sedak.com](http://www.sedak.com)



### PRIMER

## Hemp: A Durable, Low-Carbon Building Material

**This rapidly renewable material is excellent for textiles and non-structural concrete. (And no, it will not get you high.)**

by James Wilson

Building professionals are constantly presented with new, technologically advanced materials and products meant to achieve high-performance construction. But one of the best-performing materials available has been around for a long time: hemp. Cultivated in China as early as 2800 BCE, hemp offers many benefits as a building material—as well as a food and clothing material.

From colonial times through the mid-1800s, hemp was widely grown in the U.S. Because of its strength, durability, and resistance to decay, hemp fiber was commonly used to make paper, rope, canvas, and cloth. But, largely due to the fact that its cultivation has been outlawed in most states for decades, many in the U.S. have had limited knowledge about it.

One big misunderstanding about hemp is that it is a drug, but it’s not. Though hemp is part of the same species (*Cannabis sativa*) as marijuana, and looks extremely similar, it is a distinct strain with a very different chemical composition. In short, hemp does not have a psychoactive effect on humans. However, in 1970, under the Controlled Substances Act, hemp was made illegal to grow in the U.S. without a permit.

But organizations like the [Hemp Industries Association](#) are raising awareness that hemp is not a drug but a crop with many environmental benefits.

### An abundant and low-impact raw material

Hemp is a rapidly renewable resource that can be easily farmed in most

climates. As it’s naturally tolerant of disease, drought, insects, poor soil, and weeds, and it needs little water, fertilization, herbicides, or pesticides. And in addition to requiring few resources and little maintenance, hemp also sequesters carbon.

Although hemp can adapt to most soil types, it thrives in fertile, well-drained, slightly alkaline silt or clay loams. Under ideal conditions, hemp plants produce a lot of usable biomass very quickly. Compared to cotton, hemp plants can produce twice the amount of usable fiber per acre.

Hemp plants are great for soil. The plants’ fast-growing, dispersed, and penetrative root systems stabilize soil and prevent erosion. And hemp can be used for phytoremediation, removing toxins and contaminants like excess chemical nitrogen from soil.

It’s been found, too, that hemp promotes biodiversity. Compared to other common crops, hemp plants provide habitat for a greater number and wider variety of animals—especially birds, many species of which favor the plant’s highly nutritious seeds.



Photo: Fenrisulfir. License: [CC BY-SA 3.0](#).

The outer bark of the hemp plant is used to make hemp fiber that’s used to make a variety of products, including textiles and insulation. The inner, wood-like core is processed into hemp “hurds” that are used to make particle boards, bricks, and hempcrete.





Photo: Jnzl. License: [CC BY 2.0](https://creativecommons.org/licenses/by/2.0/).

*This building's exterior wall is constructed with hempcrete, a mixture of hemp hurds, lime, and water. This non-structural concrete is cast around a pre-fabricated frame structure.*

## A high-performing material

Because it is so easy to grow a lot of hemp quickly, it has the potential to be a very low-cost source of material. Nearly every part of the hemp plant can be used for something, and many hemp products—besides being highly durable and having a long lifespan—can, at end-of-life, be easily recycled, composted, or incinerated to produce biomass energy.

The parts of the hemp plant most commonly used in building products are the outer bark, used to make hemp fiber, and the core, used to make wood-like chips or "hurds."

Hemp fiber can be used to make natural insulation material with a high thermal resistance (about R-3.5 per inch) and optimal moisture regulation (water vapor resistance factor of 1-2  $\mu$ ) that can be substituted for fiberglass products. These properties are due to the structure of the hemp fiber, its many longitudinal splits and cavities increasing absorption and permeability.

Hemp fiber can also be used to make durable natural textile products like upholstery, acoustic paneling, and

wallcoverings that are resistant to abrasion, UV damage, and mildew. But to reap the full environmental benefits of hemp, look for products certified to the Global Organic Textile Standard (GOTS), which ensures that best practices are followed throughout the entire life cycle.

Hemp hurds are combined with a binding element to make non-structural board, brick, and products like "hempcrete," a non-structural, insulating, composite wall fill made by combining dried hemp hurds with lime and water. This mix is cast around a framed structure to create a breathable, highly durable, airtight envelope that's suitable for moderate climates. According to manufacturers of products like Tradical Hemcrete, hempcrete walls insulate at about R-2.3 per inch.

## Limitations

Though hemp has many great attributes, it also has its limitations. For example, although cultivating hemp requires little water and few chemical inputs, processing the plants into fiber requires a lot of energy. And in terms of using hemp fiber in building products, though it has

very high tensile strength, it has poor elasticity and is not compatible with common resins like phenol formaldehyde.

## Legalize it (again)

Due to a growing movement to legalize the cultivation of industrial hemp in the U.S., a number of [states now allow](#) it for commercial use, research, or pilot programs. And, as legalization of marijuana expands in the U.S., it is possible that hemp will be grown again and perhaps used in sustainable buildings across the country.

## For more information

International Hemp Building Association

[internationalhempbuilding.org](http://internationalhempbuilding.org)

