Renovate, retrofit, reuse: Uncovering the hidden value in America's existing building stock

About The American Institute of Architects

Founded in 1857, AIA consistently works to create more valuable, healthy, secure, and sustainable buildings, neighborhoods, and communities. Through more than 200 international, state, and local chapters, AIA advocates for public policies that promote economic vitality and public well-being.

AIA provides members with tools and resources to assist them in their careers and business as it engages civic and government leaders and the public in finding solutions to pressing issues facing our communities, institutions, nations, and world. Members adhere to a code of ethics and conduct to ensure the highest professional standards.

About this report

Renovate, retrofit, reuse: Uncovering the hidden value in America's existing building stock contextualizes the tremendous opportunity surrounding our existing buildings using economic data, expert insights, and compelling case studies. Architects and project teams can use the guiding principles described in this report to immediately unlock additional economic, health, and environmental benefits in buildings and communities.

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Existing buildings: One of our greatest opportunities

Sustained demand for architectural services on retrofits and adaptive reuse offers a chance to improve the energy efficiency of America's building stock and unlock social and economic benefits.

The work of retrofitting, renovating, adapting, and remodeling existing buildings now accounts for almost half of U.S. architecture billings, an unusually high level for a period of economic growth. New highs in boom-time renovation work represent a shifting trend with significant implications for the profession and for the environment.

Historically, the proportion of work on extant structures has risen during economic slowdowns, while new projects have burgeoned during times of ready money. But during the last decade, that trend has changed. Even as the economy has recovered from the Great Recession—and the construction sector has surged in recent years—the proportion of architects' work on existing buildings has held steady.

In 2011, at the nadir of the recession's impact on construction, renovations and adaptations had risen to 44 percent of architecture firms' billings. Instead of falling as the sector began to recover, however, that number held through 2013. In 2015, it notched up to 45 percent, and in 2017, it was still holding strong at 43 percent.[1] This steady-state engagement with America's extant stock provides increased opportunity for unlocking social and economic benefits while reducing the building sector's environmental impact.

Retrofitting buildings strengthens the local economy: Compared to new construction, a greater proportion of a retrofit's budget typically goes to labor, creating more jobs for the dollars spent. Among owners, 94 percent believe that their buildings are more valuable after a green retrofit.[2] Further, adaptation and reuse promote cultural heritage and social cohesion, which the United Nations cites as critical to community resilience.[3]

From an environmental perspective, residential and commercial building operations generate a full fifth of all U.S. greenhouse gas emissions, including 11 percent of direct emissions and a third of all emissions from electricity.[4] Buildings also embody the upstream energy used in all of the processes associated with their construction, including the production (mining, harvesting, and/or manufacturing) and transport of their constituent materials as well as the erection of the structure. Energy-efficient retrofits achieve dual savings: conserving embodied energy and curtailing operations emissions.

The Intergovernmental Panel on Climate Change's *Special Report: Global Warming of 1.5° C* makes clear the urgency of a full-out carbon reduction effort. America's pending withdrawal from the Paris Agreement notwithstanding, the American Institute of Architects (AIA), along with many others, continues to support the agreed-upon goal of reducing greenhouse gas emissions by 26-28 percent below 2005 levels by 2025.[5] With more than 90 percent of 2025's building stock already standing, improving these buildings offers our greatest chance of meeting this goal.

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1 The American Institute of Architects, *AIA Firm Survey Report 2018: Business of Architecture* (Washington, D.C.: The American Institute of Architects, 2018).

2 Dodge Data and Analytics, *World Green Building Trends 2018* (Washington, D.C.: Dodge Data & Analytics, 2018).

3 Rohit Jigyasu, et al., *Heritage and Resilience: Issues and Opportunities for Reducing Disaster Risks* (ICOMOS-ICORP, 2013), icorp.icomos.org/wp-content/uploads/2017/10/Heritage_and_Resilience_Report_for_UNISDR_2013.pdf

4 U.S. Environmental Protection Agency, "Sources of Greenhouse Gas Emissions in 2016," accessed July 27, 2018, epa.gov/ghgemissions/sources-greenhouse-gas-emissions

5 United States of America, *U.S. Cover Note INDC and Accompanying Information*, submitted March 31, 2015, www4.unfccc.int/sites/submissions/INDC/Published%20Documents/United%20States%20of%20America/1/U.S.%20Cover%20Note%20INDC%20and%20Accompanying%20Information.pdf

The US building stock

America's commercial building stock comprises some 6 million buildings, totaling around 90 billion square feet,[6] almost half of which are more than 40 years old. Over the lifespan of the existing stock, standards of sustainability, particularly energy efficiency, have evolved.

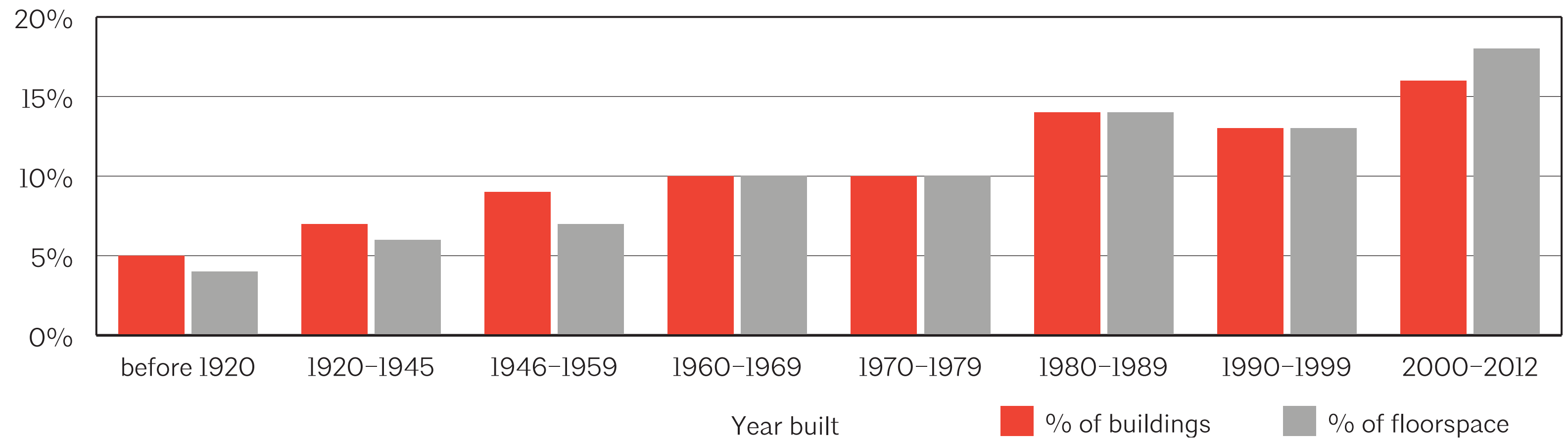
The energy use intensity (EUI) of a building is an important metric for benchmarking its operational energy consumption. EUI reflects a building's annual energy consumption per unit of area. In the US, it is typically measured as total annual energy consumption (kBTU) divided by area in square feet, and expressed in terms of kBTU/sf/year.

The EUI of extant structures varies with both age and type of use, but, overall, EUI is improving: In each category of use, buildings of a given age are more efficient now than they were 20 years ago. Variations within building use categories suggest that different periods of construction present greater or lesser challenges to improvement, and that diverse approaches to improvement have met with varying degrees of success. A closer look at each sector suggests a baseline from which to identify potential for further improvement.

Office, education, health care, hotel, and retail projects account for 64 percent of $264 billion[7] in nonresidential construction spending between 2008 and 2017, and constitute 66 percent of the square footage built in that period.[8] These sectors therefore represent a majority of the opportunities for architects to improve buildings' environmental, societal, and economic performance.

> *"We're not looking for the buildings to be stagnant in time. It's really about extending their life and their ability to serve new purposes."*
>
> —Jill Gotthelf, AIA, Walter Sedovic Architects

Share of nonresidential buildings by age of building



Source: U.S. Department of Energy, Energy Information Administration, 2012 Commercial Building Energy Consumption Survey (CBECS)

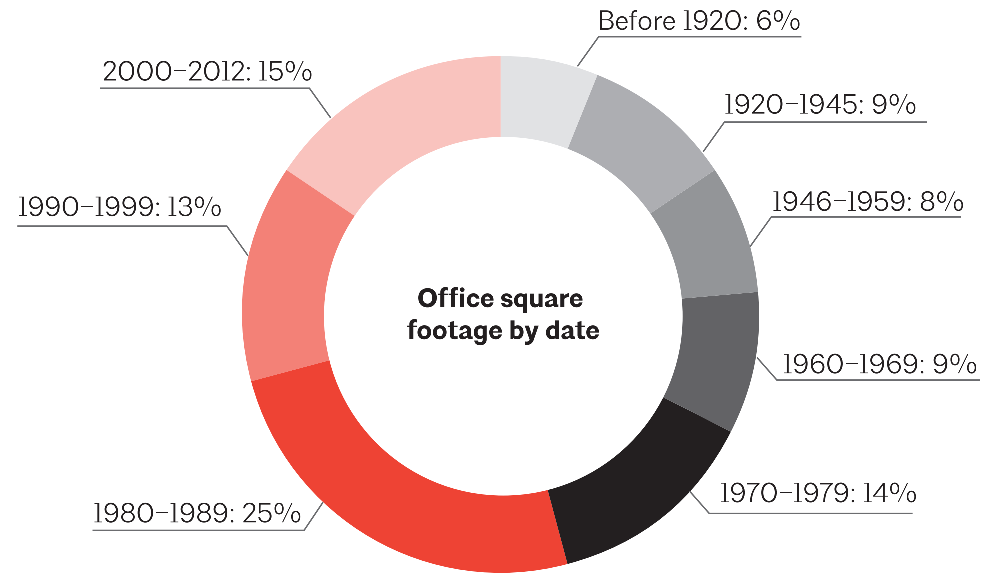
6 That estimate is based on the most recent (2012) figures from the US Energy Information Administration and is adjusted for an annual growth allowance of about 1 percent. It includes institutional and health care buildings as well as more obviously commercial buildings such as hotels, offices, and retail but excludes industrial, manufacturing, and agricultural buildings. US Department of Energy, Energy Information Administration, "Commercial Buildings Energy Consumption Survey (CBECS)," last modified March 4, 2015, eia.gov/consumption/commercial/reports/2012/buildstock

7 US Department of Commerce, "Value of Construction Put in Place Survey, 2008–2017," accessed July 27, 2018, factfinder.census.gov

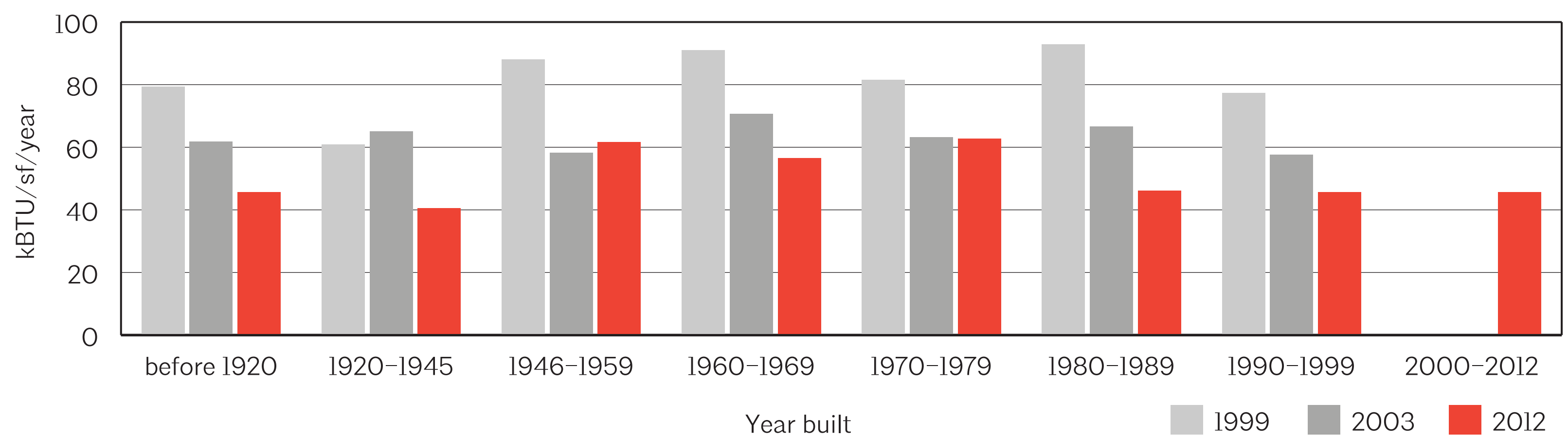
8 US Department of Energy, "CBECS 2012."

Office buildings

Office buildings attracted about 12 percent of nonresidential construction spending over the past decade. Comprising 18 percent of existing commercial buildings, this is a major sector that has achieved significant reductions in EUI. However, one cohort of office buildings, those built between 1946 and 1979, is still operating with a higher EUI than other generations. Constituting nearly a third of the nation's office stock, this cohort is fertile ground for further improvement.



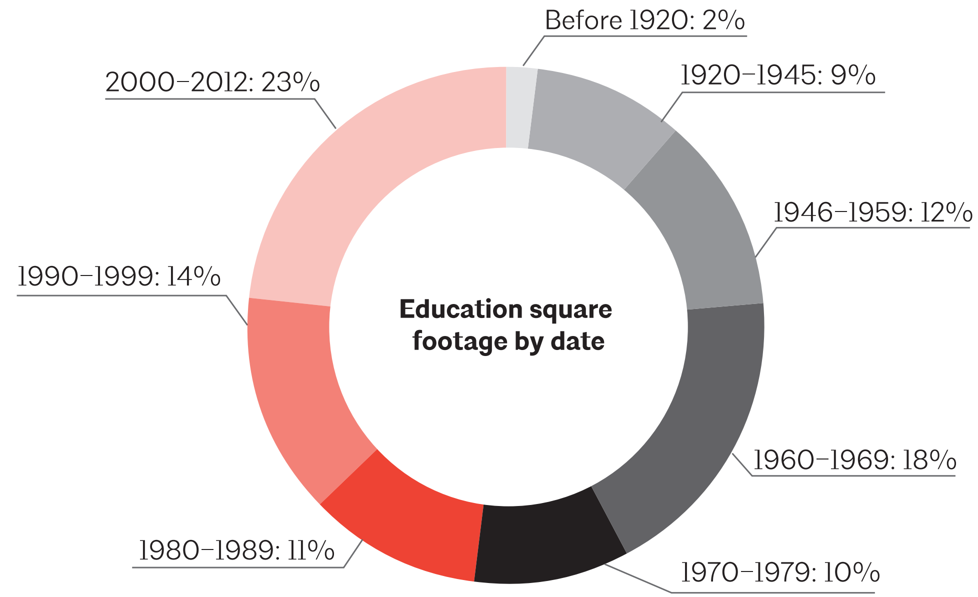
Office building energy use intensity over time



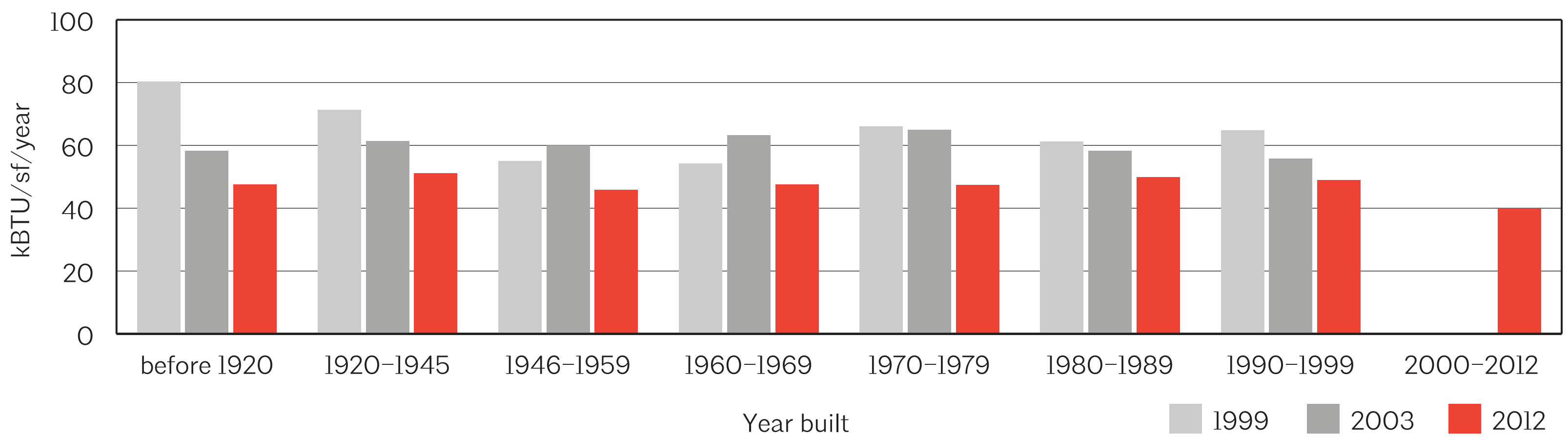
Source: U.S. Department of Energy, Energy Information Administration, 2012 Commercial Building Energy Consumption Survey (CBECS)

Education buildings

About 22 percent of nonresidential construction spending over the decade went to education. Comprising 14 percent of existing commercial building stock, this is another major sector. Improvements in recent years have brought most buildings in the sector to a similar EUI regardless of age. However, new schools built in the last 10 to 15 years are performing significantly better than their older counterparts. This suggests that about three-quarters of schools' existing square footage offers scope for further improvement.



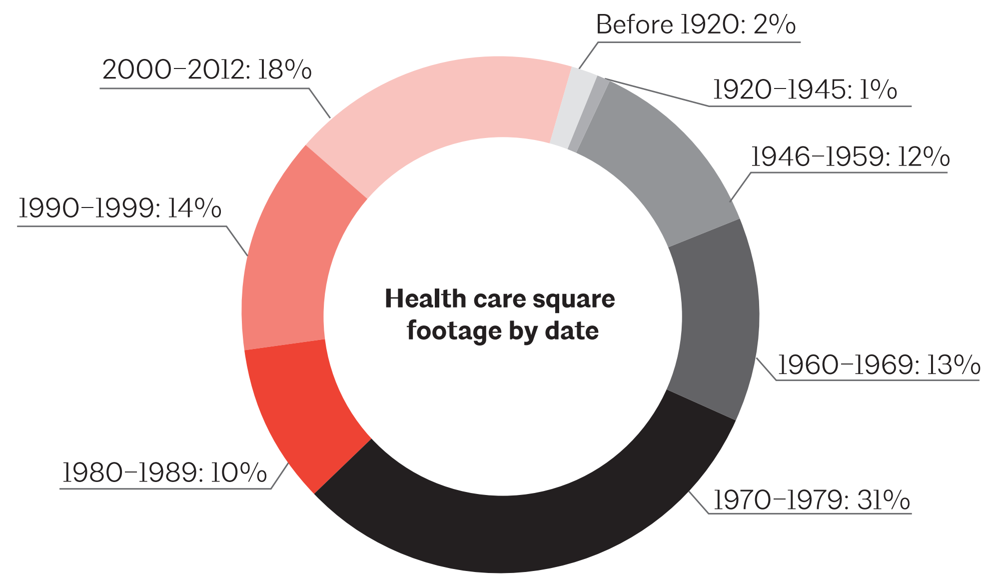
Education building energy use intensity over time



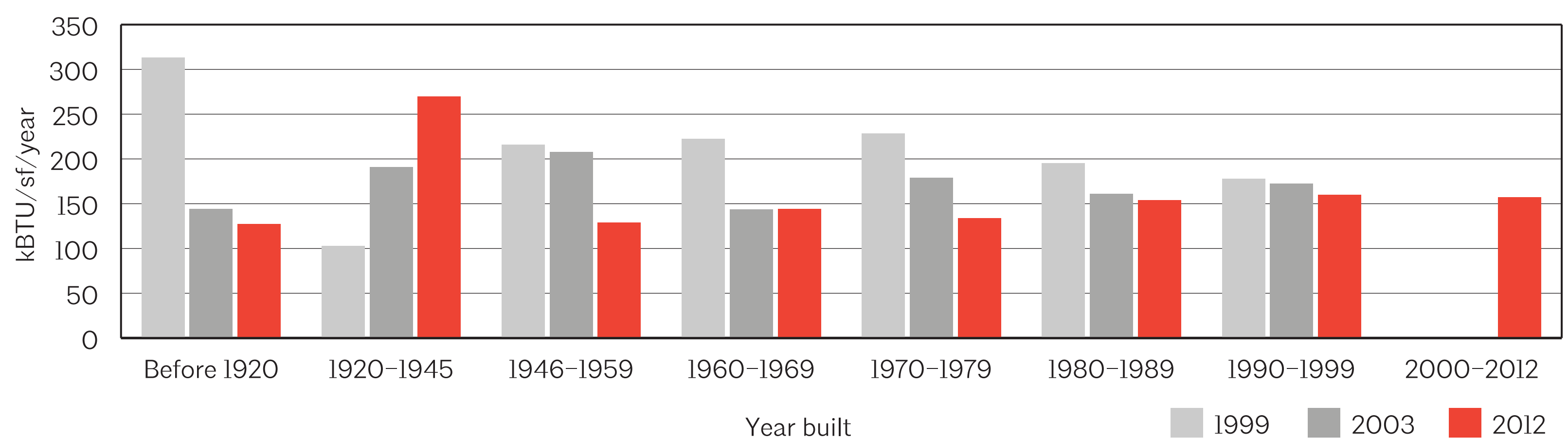
Source: U.S. Department of Energy, Energy Information Administration, 2012 Commercial Building Energy Consumption Survey (CBECS)

Health care buildings

Heath care buildings such as hospitals and medical centers account for about 10 percent of the decade's nonresidential construction spending. Comprising 5 percent of commercial building stock, this sector matters because of its high EUI. Within each generation of health care buildings, renovations have pushed EUI downward over time. (One exception, an anomalous spike in buildings built between 1920 and 1945, suggests performance in this cohort has deteriorated. The spike could be a result of a small data pool, or it could indicate that these buildings have not benefitted from renovation to the same degree as other subsets). A significant source of concern, however, is the fact that the EUI of newer buildings is rising compared to renovated stock, possibly due to the demands of newer technology and equipment. Design ingenuity is needed to lower consumption in this high-EUI typology.



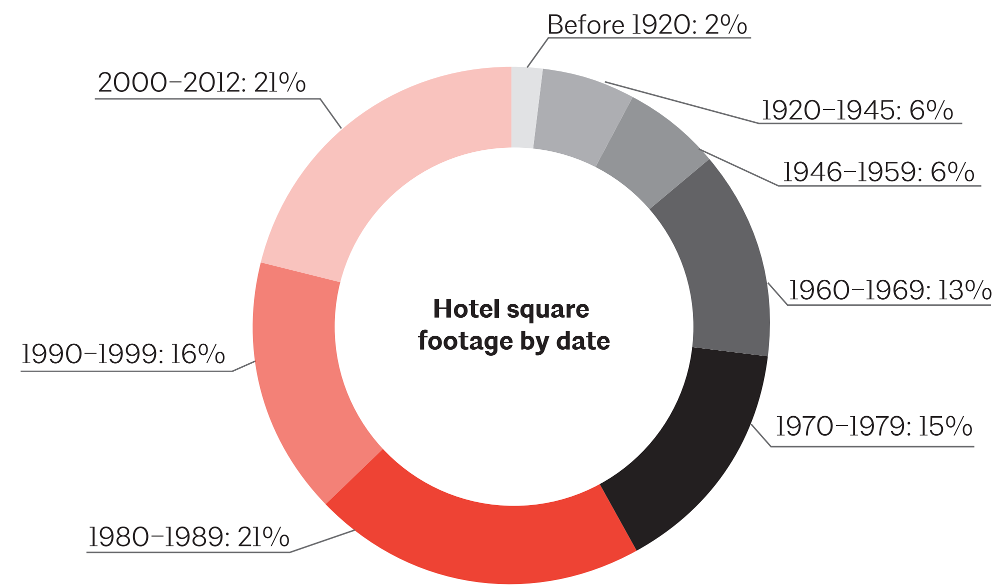
Health care building energy use intensity over time



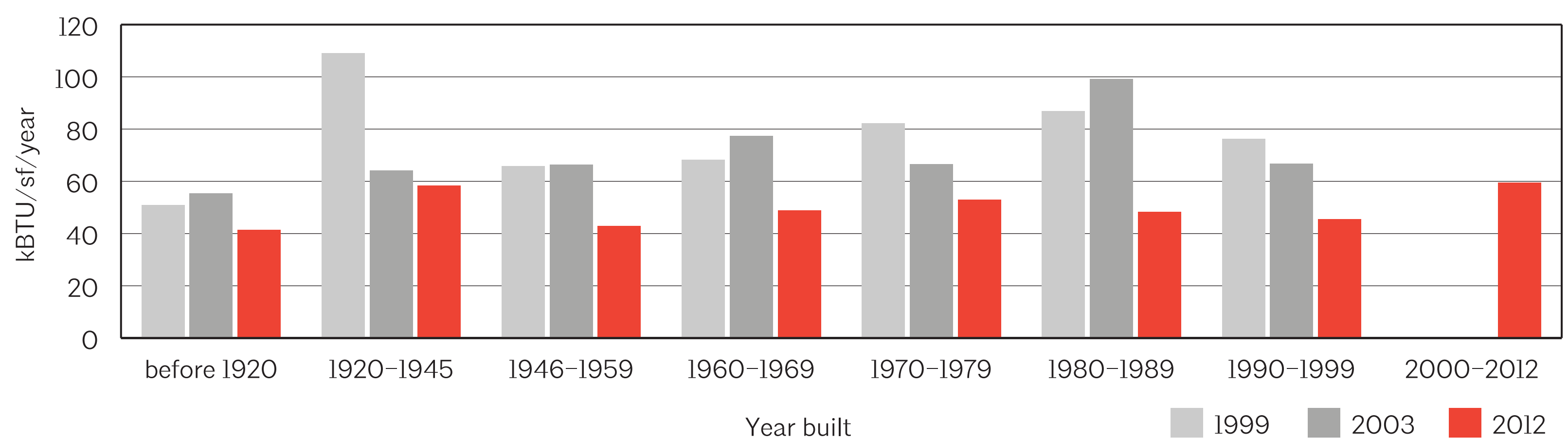
Source: U.S. Department of Energy, Energy Information Administration, 2012 Commercial Building Energy Consumption Survey (CBECS)

Hotel buildings

Hotel buildings make up 5 percent of the commercial building stock and the same percentage of the decade's nonresidential construction spending. Although the sector's EUI is not particularly high overall, and older buildings have shown strong improvement over the last two decades, consumption levels for recently built hotels have jumped. Since more than 20 percent of extant hotels have been built since 2000, their rising EUI represents a worrying trend, one that architects have an opportunity to reverse on future projects and as the recent generation comes up for renewal.



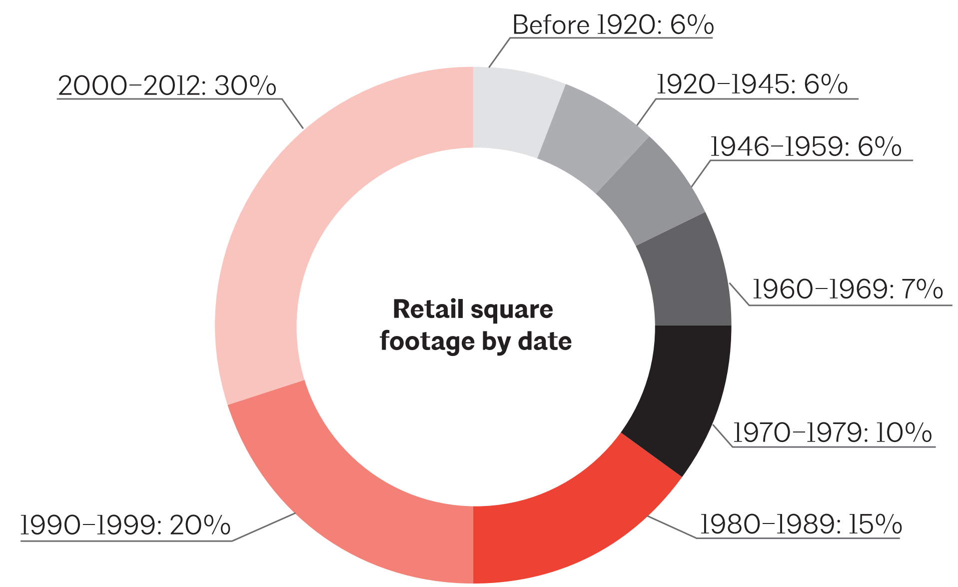
Hotel building energy use intensity over time



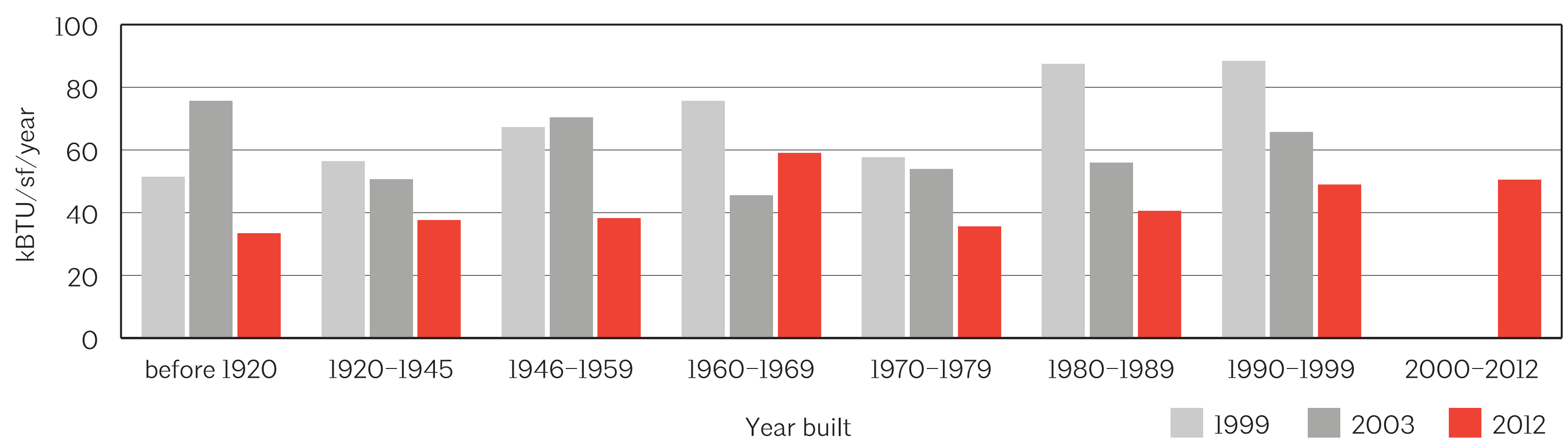
Source: U.S. Department of Energy, Energy Information Administration, 2012 Commercial Building Energy Consumption Survey (CBECS)

Retail buildings

Attracting 15 percent of nonresidential construction spending over the last decade, the retail sector is difficult to assess for opportunity because of its diversity, from restaurants through the gamut of shops and services. Notable, however, is the fact that half of all extant stores have been built since 1990, with almost a third since 2000—a much higher proportion of new construction than for other sectors—and (with the possibly anomalous exception of a few stores from the 1960s) that this cohort of new retail consumes significantly more energy than previous generations.



Retail (non-mall) building energy use intensity over time



Source: U.S. Department of Energy, Energy Information Administration, 2012 Commercial Building Energy Consumption Survey (CBECS)

Guiding principles

> *“What we often see are very material-intensive, deep-energy retrofits, which have a great story until you start looking at the carbon impact of their material”*
>
> —Jean Carroon, FAIA, Goody Clancy

Understanding the specific opportunities for retrofitting and adaptive reuse by sector can help project teams target the most poorly performing projects. The data reviewed in the previous section suggests the following priorities:

- **Office:** Office buildings from the mid-20th century offer significant opportunities for increasing value and reducing environmental impact through energy-efficient retrofits. **Education:** New schools are operating more efficiently than older ones. Energy conservation efforts in this sector should prioritize improving older schools to the new level.
- **Health care:** Newer projects are trending toward higher EUIs than buildings that have been renovated. Design ingenuity is needed to lower consumption in this high-EUI typology.
- **Hotels:** Like health care projects, new hotels are consuming more energy than ones that have been renovated, a trend that’s ripe for reversal.
- **Retail:** Though retail generally has a low EUI, the uptick in consumption among the newest buildings shows a need for savvier work in this sector.

Regardless of building use category, greater energy efficiency is needed, and architects have much to contribute. The guiding principles included here were developed by a panel of experienced practitioners, and can be applied to any project. They aren’t meant to be prescriptive; rather, they provide a starting point for improving the environmental, societal, and economic impact of extant buildings.

San Francisco Art Institute – Fort Mason Center Pier 2, San Francisco, CA

This adaptive reuse preserves the industrial integrity of an historic, U.S. Army warehouse for a modern use: an arts educational center complete with advanced sustainable building systems.

© Bruce Damonte

1 Establish clear goals.

Make the project team's reasons for retrofitting explicit, and develop clear goals to express them. While these will vary according to the circumstances of each project (as the following case studies show), retrofits share a common advantage: Compared to even the most efficient new buildings, they start out with a fraction of the carbon debt. How will you capitalize on that?

Beyond energy and resource conservation, retrofitting may also serve economic and social objectives. Architects who can frame a renovation in terms of these goals are more effective advocates for sustainability while adding value to their service. Retrofitting an office to a net zero energy standard, for example, can cost scarcely more than a new building but prove significantly more profitable over time. From a social justice perspective, retrofitting puts proportionately more money into the workforce instead of into the walls, keeping dollars in the community and sparking the local economy.

Consider completing a vulnerability assessment before beginning a renovation to help determine building performance goals, mitigate potential hazards, and increase the building's resilience as circumstances change. Because vulnerabilities vary over time in response to multiple factors, iterative assessments over a building's lifetime are appropriate. Indeed, a vulnerability assessment may be necessary when a building undergoes a substantial alteration, renovation, or remodel, or if it is part of a mandatory retrofit program.

2 Unlock the existing building's full potential.

Many older buildings have good passive bones. Built before central heating and air conditioning, they were designed with vernacular strategies for comfort. Thick masonry walls mitigate diurnal temperature swings, for example, and tall double-hung windows allow rooms to self-ventilate. Such technologies create opportunities for lower-carbon design. Their more explicit relationship to the natural environment may also foster the well-being of occupants.

When historic buildings aren't comfortable, it's often because their original systems have been corrupted. To get the most from passive systems, you may first need to restore them. For example, reopen sealed clerestory and operable windows to activate a cooling chimney effect, repair a radiant perimeter heating system, remedy site and roof drainage to keep walls dry (and therefore more inherently insulative), and monitor for areas where increased insulation will really make a difference. You will need to make fewer interventions once the building is working the way it should.

> *"The most logical thing we can do to decrease our impact on the planet is to reuse what already exists."*
>
> –Jean Carroon, FAIA, Goody Clancy

The Renwick Gallery of the Smithsonian American Art Museum, Washington, D.C.

The design team restored two long-concealed vaulted ceilings and re-created the original 19th-century window configuration as part of the museum's award-winning renovation.

Image provided by: DLR Group | Weslake Reed Leskosky | © Kevin Reeves

3 Prioritize the most effective interventions.

Start with a thorough analysis of what you've got: What is your building, and what are its opportunities, issues, and problems? When working with an existing structure, you can monitor actual performance in real time—ideally with occupants. Is there flexibility with zoning, a need for more light, an opportunity to improve thermal comfort? Even a vacant building lets you see how its different areas are functioning—and make strategic decisions about use and occupancy. Something as simple as a blower door test will tell you a lot.

Then you will want to target your upgrades. Rather than fixing everything, look for places of major heat loss and fix those. Using fewer materials generates fewer emissions—and reduces costs, too. What could you manage without?

Consider the building as a whole system, including the potential for on-site renewable energy. A building envelope and mechanical, electrical, and plumbing (MEP) upgrade, combined with effective control systems and reduced plug loads, can bring an ordinary building surprisingly close to net zero energy. Bring consultants in early to advise on potential synergies. Building performance simulation (BPS) of thermal loads, solar access and shading, daylight and glare, natural ventilation, and embodied carbon can predict the impact of proposed interventions and help maintain sustainability goals through successive iterations.

Upgrading the building envelope should be an early consideration, especially since old buildings tend to be leaky. But to avoid creating new problems, consider retaining a building science expert. An architect unfamiliar with older assemblies might, for example, unadvisedly insulate one side of a historic masonry wall with spray foam, thereby accelerating freeze-thaw deterioration and promoting corrosion of metal elements in the wall. (Speaking of foam insulation, take a look at its embodied carbon: Will the operational savings justify it?)

You also need to provide for ongoing upgrades. Separation of MEP systems can more readily facilitate future improvements. Scheduled replacements of lights and equipment are opportunities for efficiency leaps: Since the expense of the replacement is already in the budget, a quantum leap doesn't cost much more and nets a bigger return.

4 Consider total carbon impact: operational and embodied energy.

As the IPCC's *Special Report: Global Warming of 1.5°C* makes clear, we face a critical time crunch for reducing carbon emissions. It's now understood that global warming beyond 1.5°C significantly worsens the prognosis for catastrophe; and if we're to stay within that maximum, only a dozen years remain for implementing the required changes. The AIA 2030 Commitment program offers architects a way to publicly express their dedication and lead the way toward energy-efficient buildings and a now-urgent carbon-neutral future.

In addition to more efficient operations, which the majority of sustainability paradigms focus on, reducing embodied emissions will be essential to success. The latter include greenhouse gases generated in the extraction, manufacture, transport, and assembly of materials. (Some definitions of embodied energy also include demolition and disposal in the calculus; others assign these to a separate life cycle assessment.) Savings in embodied emissions are immediate and can be achieved by reducing the use of materials overall—for example, by retrofitting an existing building instead of building new, by minimizing the material needed to do so, and by using low-carbon materials for remaining needs. Resources such as the Carbon Smart Materials Palette and informed consultants can help.

Consider offsetting inevitable embodied emissions by purchasing carbon credits to eliminate equivalent emissions elsewhere. Otherwise, even a net zero energy building will take years to offset its own embodied energy before it's truly carbon neutral—years the IPCC report suggests we no longer have.

> *"The industry right now is really starting to look at full life cycle carbon accounting and starting to build the tools to do that."*
>
> —Jean Carroon, FAIA, Goody Clancy

St. Patrick's Cathedral, New York, NY

New geothermal and MEP systems are designed for future extreme weather and potential program expansion.

© John Baer

5 Consider health impacts of new and existing materials.

Conduct a hazardous materials inspection at the outset of the project. Some materials, such as asbestos in flooring, may be more safely encapsulated and left in place. Others, such as lead, will need to come out. And now that health is on the project's agenda, look for ways to follow through as you select new materials.

Selecting, documenting, and orchestrating the use of materials to optimize a project's health and environmental impact from top to toe can be downright hard, but significant incremental improvements are surprisingly easy to achieve. Consult AIA's Healthier Materials Protocol for clear, practical methods for selecting materials that are better for human and environmental health.

> *"Until recently, retrofits were making buildings maybe 20 percent better. But now it's realistic to ask, 'How do we get an existing building all the way to net zero?'"*
>
> —Larry Strain, FAIA, Siegel & Strain Architects

6 Design to accommodate future change.

Much of the value of an existing building lies in its ability to adapt to new uses. Think in terms of loose fit: How can your project achieve its goals so that the building remains adaptable? Can materials and assemblies be designed for reuse? Designing for flexibility extends the life of the building, and provides future generations with their own chance to retrofit.

With insight from:

Larry Strain, FAIA, Principal, Siegel & Strain Architects

Jean Carroon, FAIA, Principal, Goody Clancy

Jill Gotthelf, AIA, Principal, Walter Sedovic Architects

Kevin Bates, President/Owner, Sharp Development Company

Ortlieb's Bottling House, Philadelphia, PA

Philadelphia-based architecture firm KieranTimberlake transformed a former beer bottling plant into a new open office studio.

© Michael Moran/OTTO

High-performance retrofits: three case studies

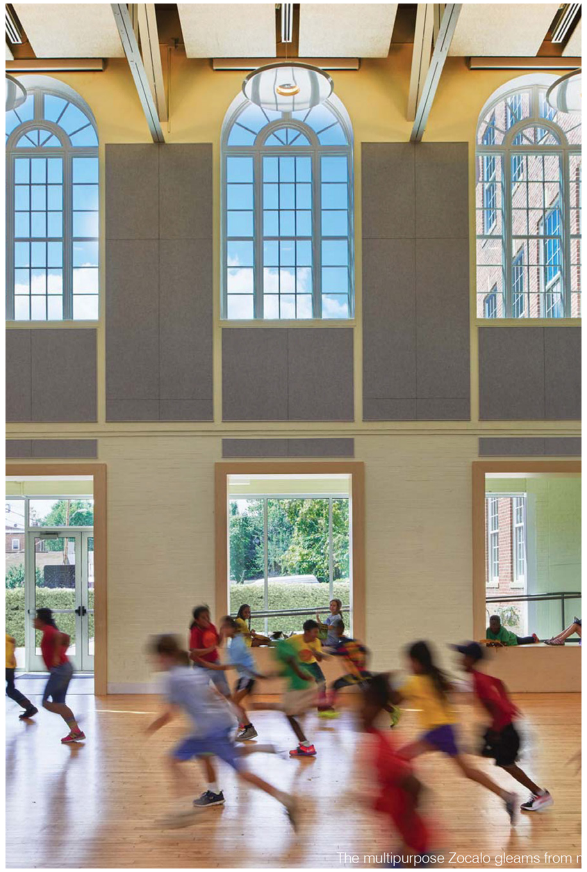
The following case studies of recently completed renovations in a variety of typologies—a school, an office, and a hotel, each completed within the last decade—illustrate these guiding principles in action.

The renovation of the Mundo Verde Bilingual Public Charter School Campus brings a new lease on life to a historic school building, achieving a high level of environmental and pedagogical performance for about half the cost of comparable schools attaining lower levels of sustainability. The transformation of an ordinary two-story urban building into DPR Construction's net zero energy headquarters provides a model for upgrading thousands of similar buildings across the country; it's also the subject of a groundbreaking study in quantifying embodied energy. And at a time when energy performance in the hospitality sector is regressing overall, 1 Hotel South Beach makes a virtue of environmental responsibility, reconciling green values with a sumptuous aesthetic in the LEED Silver renovation of a beachside behemoth.

Each project represents a significant energy achievement in the context of a larger story that encompasses priorities for health, equity, economics, and resilience. Together, they offer insights and inspiration for upgrading more of America's existing building stock.

1 Renovate to educate

Mundo Verde Bilingual Public Charter School Campus



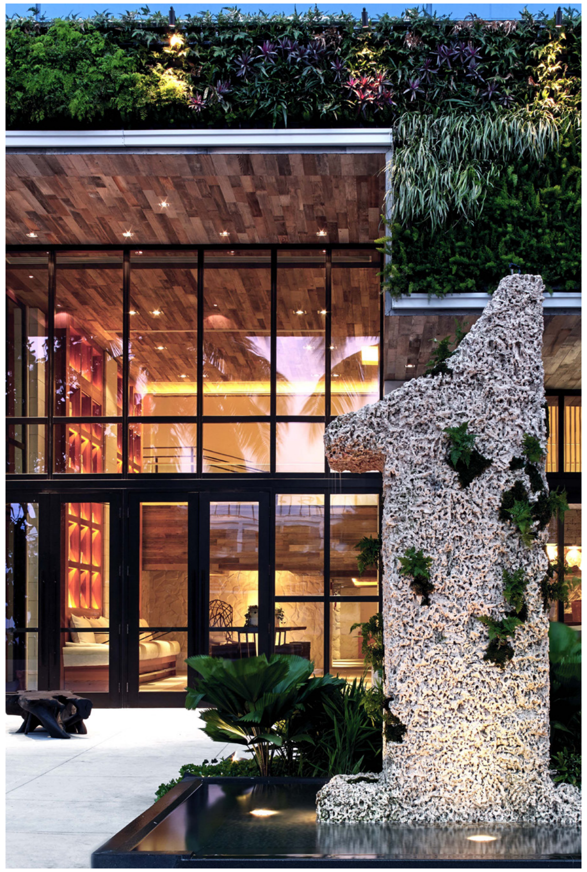
The multipurpose Zocalo gleams from n

2 Total carbon takedown

DPR Construction, San Francisco Regional Office

3 Hospitality goes green with a biophilic retrofit

1 Hotel South Beach



1 Renovate to educate

Mundo Verde Bilingual Public Charter School Campus

Guiding principle: Consider total carbon impact.

By maintaining 97 percent of existing structural materials, the design team was able to reduce the school's total carbon impact.

Image provided by: Studio Twenty Seven Architecture | © Anice Hoachlander, Hoachlander Davis Photography, LLC (hdphoto.com)

The impact of sustainability measures in a school extends far beyond the building. It shapes the ideas and expectations of students, family members, visitors, and staff for generations. Mundo Verde, a public charter school in Washington, D.C., is maximizing this potential. In 2013, when the school was assigned a shuttered 90-year-old brick building to renovate for its new home, it made curriculum-integrated sustainability the design team's core mission. Winner of an AIA 2018 COTE® Top Ten Award, the 47,000-square-foot revitalization, including a new 11,000-square-foot annex, exemplifies environmental stewardship through site repair and reduced resource consumption.

As a renovation, the project enjoyed a head start on reducing consumption. The embodied-carbon debt of the materials in the existing building had amortized over its 90-year lifespan. "We were starting with a building with essentially a zero-carbon footprint," says Todd Ray, FAIA, formerly with Studio Twenty Seven Architecture, where he led this project, and now a principal at Page. "So how do we renovate in ways that keep that footprint minimal?"

Environmentally responsible decision making focused on three key priorities: materials, energy, and water. Existing structural materials were almost entirely retained (97 percent), and finishes—including hardwood floors discovered beneath layers of carpet and tile—were reused whenever possible. For elements unsuitable for reuse on-site, the project diverted 75 percent of construction waste from landfill. New components such as millwork and additional flooring were selected from recycled and renewable content, with over a third of the project's inputs produced within 500 miles of the site—triple the minimum required for LEED's regional materials credit. And because forest management practices also affect a building's carbon impact, over 98 percent of all new wood-based materials in the project are Forest Stewardship Council (FSC)-certified.

Design for energy conservation began with upgrades to the building's envelope—and here the design team had to make some strategic choices. With a limited budget, top priorities included insulating the roof and replacing 1970s-era windows with high-performance glazing units in thermally broken frames. But insulating the original triple-wythe masonry walls didn't offer enough energy savings to warrant the cost. Each project must be individually assessed, says Kevin Cahill, a principal at Interface Engineering, commissioning firm for the project, "but for two stories or less, insulating the roof—because it's always seeing the sun—tends to get a bigger bang for the buck."

Supporting these improvements to the building's passive performance, MEP systems were designed for energy efficiency, both in terms of first cost and long-term use. Outdoor air supply, for example, typically accounts for 40 percent of a school's energy use, but at Mundo Verde, a heat-recovery system tempers it, and CO_2 sensors control its distribution so it gets delivered to occupants and not to empty rooms. Heating and cooling energy are transmitted

Guiding principle: Prioritize the most effective interventions.

An insulated roof and high-performance glazing units deliver cost-effective energy savings.

Image provided by: Studio Twenty Seven Architecture

© Anice Hoachlander, Hoachlander Davis Photography, LLC (www.hdphoto.com) by a variable refrigerant flow (VRF) system, which uses less energy and material than a conventional system: Small refrigerant piping about an inch in diameter delivers the same heating and cooling energy as a foot-square air duct. “VRF is a nice retrofit solution,” says Cahill. “Keeping systems that weren’t there originally as discrete as possible allows you to retain more of the original character.” Mundo Verde’s 14-foot ceilings, for example, didn’t need to be dropped to accommodate it. The HVAC system combines with daylight harvesting, energy-efficient lighting fixtures, and sensors to bring the project’s predicted overall EUI to 61 kBtTU/sf/yr, an almost 60 percent reduction compared with the national average for schools.

Water was the third area of focus in the retrofit. Replacing existing fence-to-fence asphalt with a variety of porous surfaces, including food and habitat gardens, positions the school grounds to manage a hundred-year storm entirely on-site, reducing the burden on—and need for expansion of—municipal infrastructure. Capturing roof water in a 25,000-gallon cistern for irrigation and toilet flushing saves an estimated 300,000 gallons of potable water per year. And because a lot of water can run down the drain while children play with sensor-activated faucets, timed faucets were selected for more effective conservation under the circumstances.

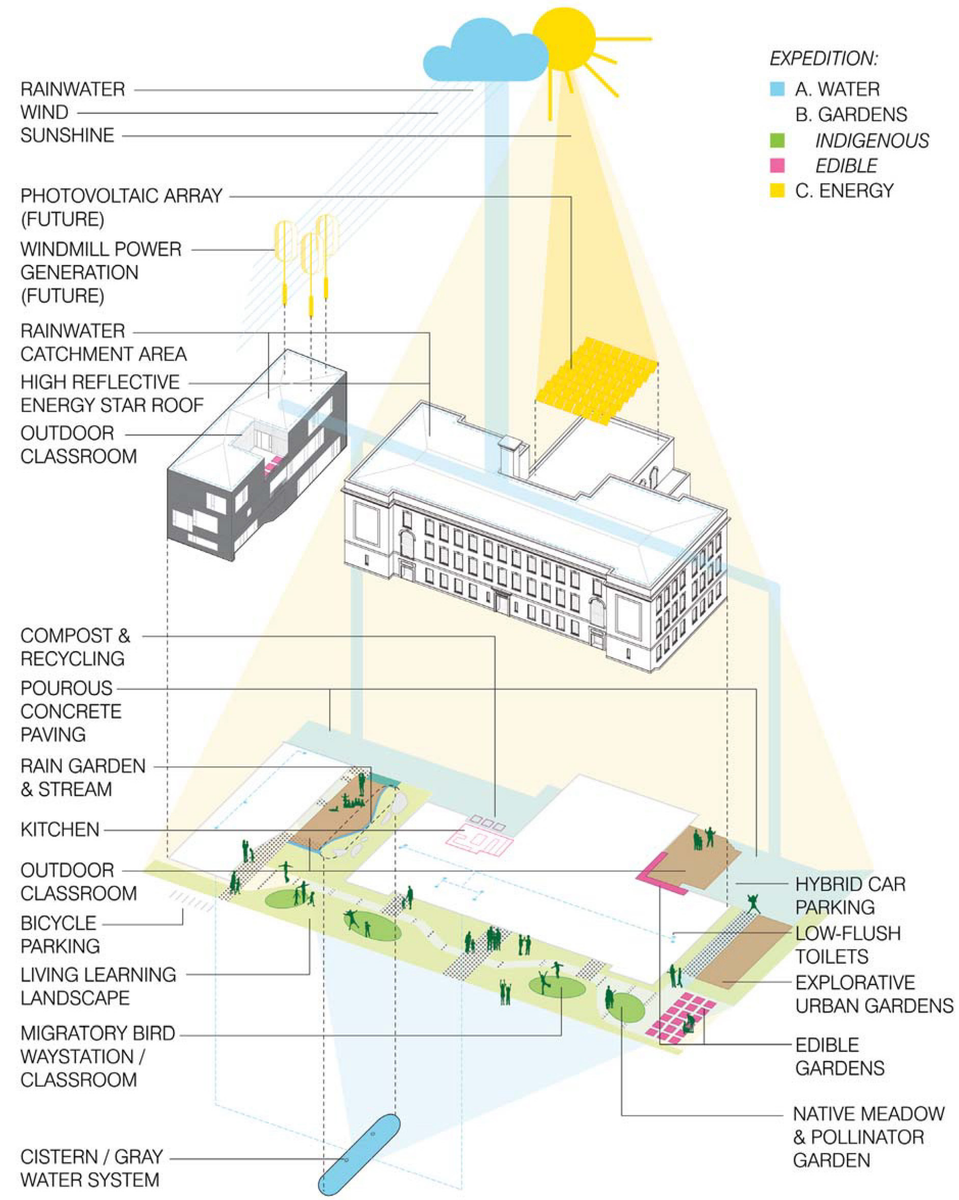
Mundo Verde’s retrofit gives a new lease on life to what Ray calls a beautiful execution of an original school typology. It also demonstrates that environmental and financial responsibility can be compatible: The renovation achieved LEED Gold certification (in addition to its embodied-carbon savings), and the annex achieved LEED Platinum, all for about half the construction cost of comparable regional public schools attaining lower levels of sustainability. As the building recommences its useful life as both a place and a subject of learning, Ray predicts that “500 young minds constantly looking for ways it could become even more sustainable are going to make some amazing discoveries.”

Image to right >

Guiding principle: Design to accommodate future use.

Porous surfaces and a 25,000-gallon cistern contribute to the school’s resilience. The site is designed to manage a hundred-year storm without burdening city infrastructure.

Image provided by: Studio Twenty Seven Architecture



Mundo Verde Bilingual Public Charter School Campus project information

Location
Washington, D.C.

Completion date
2015

Project area
47,229 sq ft

Site area
0.97 acres

Actual costs—site development
$1,025,000

Actual costs—building cost renovation
$7,126,000

Actual costs—building cost annex
$3,350,000

Actual costs—furnishing costs
$75,000

Actual costs—technology costs
$25,000 Cabling + $75,000 Hardware

Certifications
LEED Gold (renovation), LEED Platinum (annex)

Owner
Mundo Verde Bilingual Public Charter School Campus

Architect
Studio Twenty Seven Architecture

Project manager
TenSquare

Contractor
Forrester Construction

Civil engineer
Christopher Consultants

Structural engineer
Ehlert/Bryan Inc.

MEP engineer
CS Consulting Engineers

Commissioning firm
Interface Engineering

Landscape architect of record
Carvalho + Good Landscape Architects

Consulting landscape architect
Siteworks Studio

Food service consultant
Next Step Design

Acoustical consultant
Hush Acoustics

Geotechnical engineer
CTI Consulting Inc.

Guiding principle: Establish clear goals.

Food and habitat gardens reflect the design team's core mission: curriculum-integrated sustainability.

Image provided by: Studio Twenty Seven Architecture

2 Total carbon takedown

DPR Construction, San Francisco Regional Office

Guiding principle: Establish clear goals.

Biophilic design features such as living walls contribute toward a cost-effective, desirable, and salubrious workplace.

Image provided by: DPR Construction | © Drew Kelly

Total carbon takedown

DPR Construction, San Francisco Regional Office

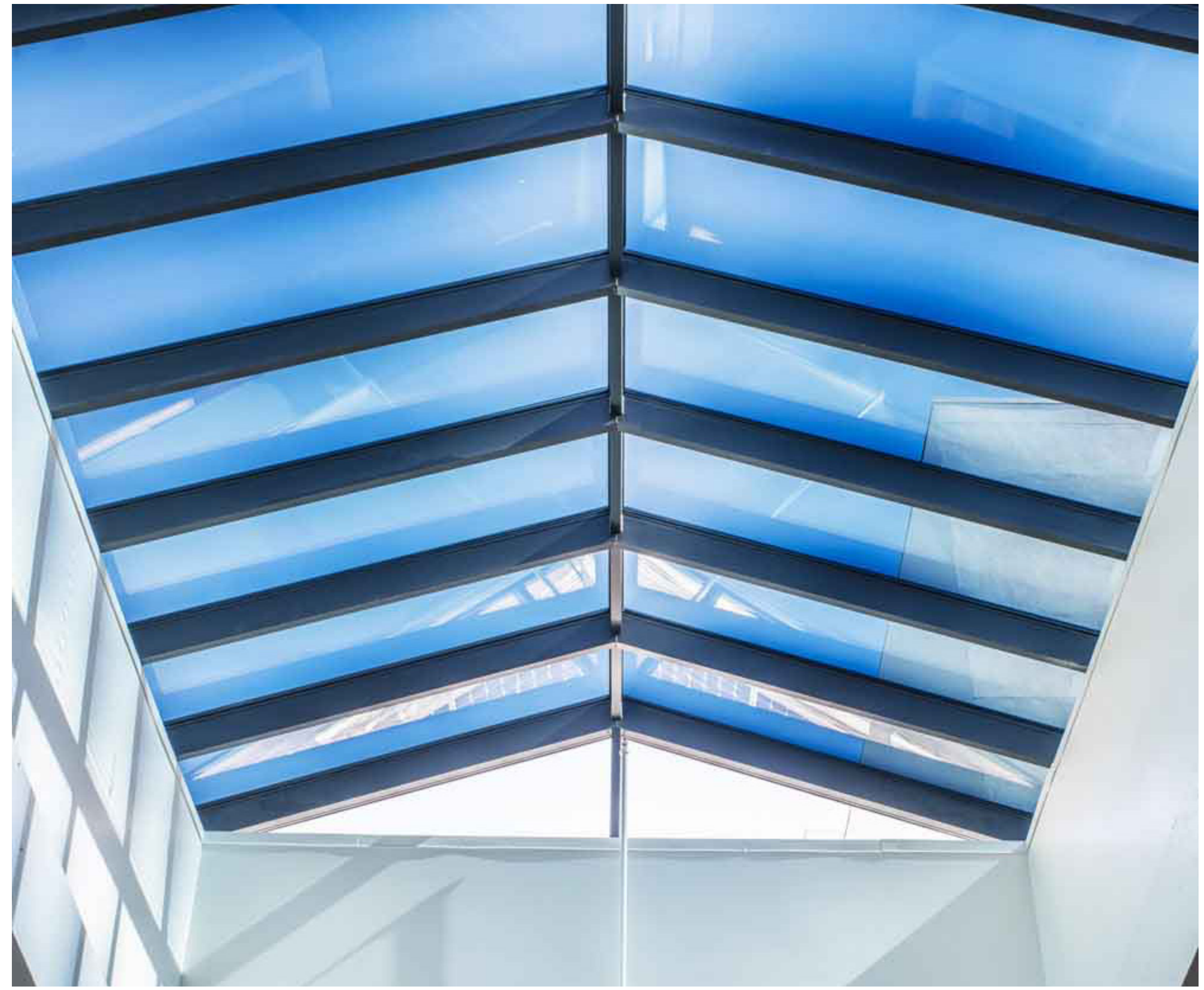
America's existing building stock generates more than 2 billion tons of greenhouse gas emissions per year. DPR Construction's transformation of a two-story urban building into a zero-carbon office provides a hopeful precedent for lowering that number. In addition, the 24,000-square-foot renovation, now the firm's San Francisco headquarters, cost no more than a standard Class-A tenant improvement.

"The idea that you can take a modest building and make it high performance using one general strategy was to me a bit of a surprise," says Eric Ibsen, chief design officer at San Francisco-based Forge (formerly FME Architecture + Design), architect for the LEED Platinum renovation. Surrounded by taller buildings on three sides, and clad on the fourth with heritage-designated aluminum storefront glazing (impermissible to upgrade), the 1950s-era site-cast concrete structure didn't stand out as a zero-carbon candidate. Yet with a few well-considered choices, it became the first office building in San Francisco to achieve net zero energy certification with the International Living Future Institute.

The key tactics in that achievement were simple: adding insulation to the roof, upgrading MEP systems and controls, daylighting with skylights, reducing plug loads, and adding solar energy systems to power remaining demand. Completed in 2014 with a target EUI of 24 kBTU/sf/yr (less than half the building type's California average), the office is outperforming its goal. Operating at an EUI of about 20 kBTU/sf/yr, it is returning between 10 and 20 percent of its annual solar energy production to the grid.

Complementing the project's achievements in sustainability are its measures for habitability. To support occupant well-being, the renovation provides 30 percent more ventilation air than what is required by code, with a dedicated outdoor air supply (DOAS) and superior filtration. Vertical and atrium skylights provide ample daylight. Strategies for enhanced thermal comfort include roof vents for passive ventilation and personal fans for occupant control. Biophilic design features such as living walls further improve air quality and lift building users' spirits with the beauty of nature. A design-build-assist delivery method provided rapid costed options for meeting design goals, allowing the project to come in at just $185 per square foot.

Achieving a cost-effective, desirable, and salubrious workplace for zero operating emissions is only part of the story, however. Each year America's 6 billion square feet of new construction embodies 150 million metric tons of greenhouse gases from the extraction, manufacture, and transport of materials, and the demolition and construction of assemblies—that's before the 25 million metric tons of annual operating emissions even start. As a retrofit, the DPR office slashed both types of emissions, for a total carbon achievement.



Guiding principle: Prioritize the most effective interventions.

The design team prioritized a handful of highly effective strategies to reduce EUI, including insulating the roof, adding onsite solar, and daylighting with skylights.

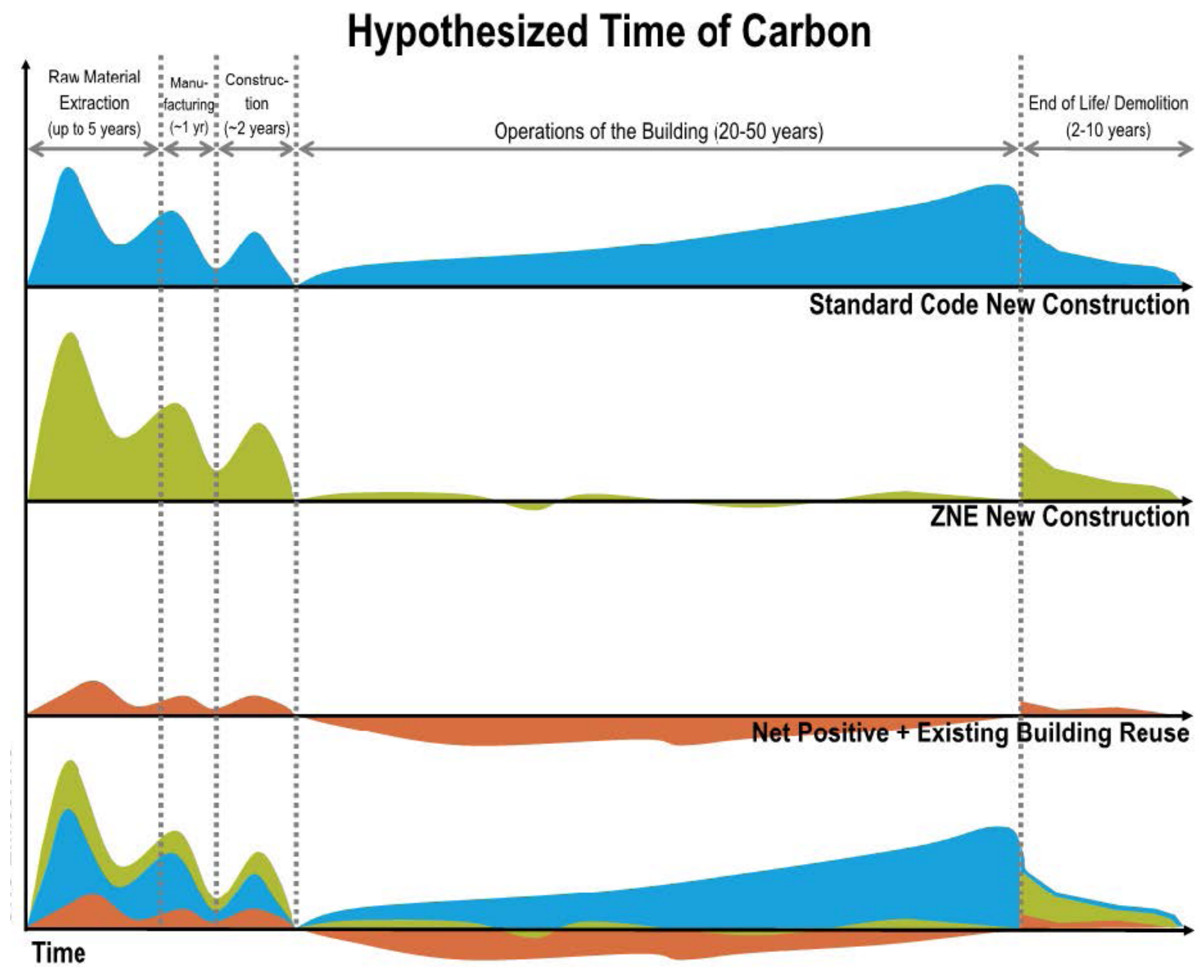
Image provided by: DPR Construction | © Drew Kelly

Instead of spreading over time, as savings in operating emissions do, embodied emission savings are immediate, which make them especially valuable in the carbon-reduction race. But because they're difficult to quantify, they're often ignored in sustainability planning. To help change that, a group of experts in life cycle assessment (LCA) has used the DPR renovation as a case study. Using LCA software to pull material quantities from the project's digital model and correlate them with environmental metrics, the study evaluates the carbon savings of the decision to renovate rather than build new.

Even with a structural upgrade required by the weight of the rooftop solar systems (wood trusses were reinforced with some strategic steel), reusing an existing building achieved a nearly 70 percent reduction in embodied carbon emissions compared to constructing the same project from scratch. "We were blown away," says Megan White, chief sustainability officer at Integral Group, one of the authors of the study, along with Siegel & Strain Architects and the Ecological Building Network. "The savings were way more than we'd hypothesized." The project's biggest cuts to embodied carbon came from its reuse of high-mass materials, such as its concrete structure, and energy-intensive materials, such as the heritage-protected aluminum curtain wall.

Making vivid the implications of DPR's total carbon achievement is the study's schematic diagram comparing emissions of standard code-compliant construction, NZE (net zero energy) construction, and net positive energy in tandem with building reuse on a timeline from raw material extraction to demolition/end-of-life. Even compared to NZE construction (the current gold standard for new buildings), the strategy of renovating an existing building to NZE achieves impressive savings.

The ability to repeat this work for similar building stock throughout the country implies the possibility of real progress in meeting the nation's carbon challenge, says Ibsen. "There are so many of these low-performance, two-story, light-industrial or office buildings," he says, "millions of square feet in the Bay Area alone." With DPR as proof, "we can now say to a building owner or client, 'Look: Take your modest low-performance building and consider this investment. The payoff is completely worth it, and the story is terrific too.'"



Rough order of magnitude evaluation of total GHG emissions over time for three building types: standard code-compliant new construction, zero net energy (ZNE) new construction, and net positive existing building reuse.

Image provided by: Wes Sullens

DPR Construction, San Francisco Regional Office project information

Location
San Francisco

Completion date
2014

Project area
24,000 sf

Construction cost
$185/sq ft

Certification
LEEP Platinum; ILFI Net Zero Energy Building

Actual energy use
134,800 kWh

Actual energy use intensity
20.3 kBTU/sq ft

Actual electricity generated
152,000 kWh

Net energy generation
17,200 kWh

Owner
DPR Construction

Architect
FME Architecture + Design (now Forge)

Interior design
FME Architecture + Design (now Forge)

Project director/manager
DPR Construction

Contractor
DPR Construction

Structural consultant
Paradigm Structural Engineers

MEP consultant
Integral Group

LEED consultant
Environmental Building Strategies

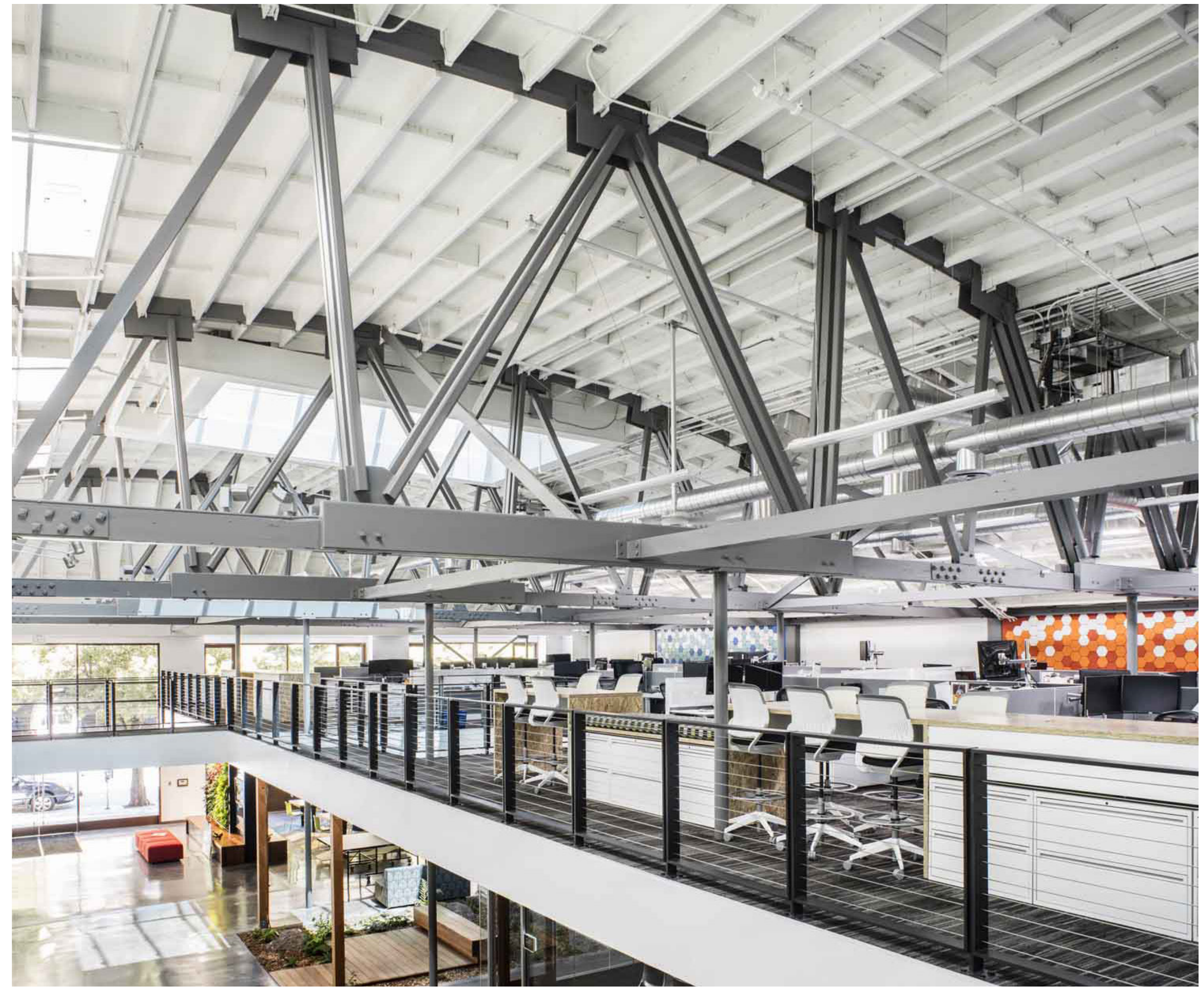
Lighting design
DPR Construction

Landscape & green wall
Habitat Horticulture

Mechanical contractor
Anderson, Rowe & Buckley

Electrical subcontractor
Decker Electric

Embodied carbon analyst
Integral Group



Guiding principle: Consider total carbon impact.

Even with structural upgrades required to support the rooftop solar systems, the project team achieved a nearly 70 percent reduction in embodied carbon emissions by leveraging an existing building.

Image provided by: DPR Construction | © Drew Kelly

3 Hospitality goes green with a biophilic retrofit

1 Hotel South Beach

Design principle: Consider health impacts of materials.

The design team used natural and reclaimed materials to achieve a restorative biophilic retreat.

Image provided by: Kobi Karp Architecture & Interior Design

In an industry typically known more for consumption than conservation, Starwood Capital Group's 1 Hotel brand aims to combine luxury-level comfort and service with eco-conscious design. "I wanted to capture the beauty of nature in a hotel and commit to safeguarding it as best I can," says Starwood CEO and Chairman Barry Sternlicht on the hotel's website. And with a nod to the brand's moniker, he adds, "It's 1 world." For 1 Hotel's inaugural property, completed in 2015 at a cost of $200 million, Starwood renovated a 1.045 million-square-foot, 426-room 1970s behemoth in Miami Beach's South Beach.

The impact of the renovation on the building's urban context is central to its recycling and restoration story, says Kobi Karp, AIA, principal at Kobi Karp Architecture and Interior Design. The building used to focus only on the beach, with just a narrow lobby opening perpendicular to the street. But in a move that earned the project the support of the city's Historic Preservation and Review Board, a new glazed façade connects the hotel to the city. Shops, a restaurant, a fitness studio, and a lobby now oriented parallel to the street enliven a previously underused promenade; a plaza and 3,000 square feet of living wall contribute greenery; and a generous wood-soffited canopy offers a warm welcome. "Instead of sitting on Collins Avenue with its arms crossed," says Karp, "the hotel now opens its arms in a gesture that invites the public in."

Inside, the sheer size of the building posed the renovation's primary design challenge. "It was this over-scaled, overwhelming presence on the beach," says Mike Casey, formerly with Meyer Davis and the interior architect for the project, "and we were tasked with making a retreat where guests would feel a sense of escape and connection with nature." To tackle the challenge, the architects looked for inspiration in the landscape, seeking ways to translate the power and serenity of the Atlantic seaside into design. They made extensive use of natural materials, both to support the biophilic design concept and to contribute an inherent sense of scale.

The hotel backs its nature-based ethos with LEED Silver certification. Compared to the LEED-prescribed baseline building, the project achieved energy savings of about 15 percent, while improving indoor air quality with 100 percent outdoor ventilation air. "For a retrofit, that's very good," says Rob Hink, principal at The Spinnaker Group, sustainability consultants to the project, "because a lot of the energy-saving strategies you'd consider for new construction may not be available on an existing building." For example, the existing HVAC system was still serviceable, so rather than discard it in favor of a new state-of-the-art system, the team switched in high-efficiency chillers and boilers, with future upgrades planned as part of the maintenance schedule.

Prioritizing the most effective interventions led the project team to mitigate the building's heat-island effect: "Here in South Florida, we have a big solar load on our buildings," says Hink, so paving material with a high solar-reflectance index covers 80 percent of the

Design principle: Establish clear goals.

A new glazed façade, plaza, and living wall embody the hotel's luxurious eco-conscious goals and enliven a previously underused promenade.

Image provided by: Kobi Karp Architecture & Interior Design

hotel's roof, and rooftop pools do double-duty as an amenity and as a shading device for the roof beneath. Additional improvements include high-performance glazing, sensor-controlled LED lighting, low-flow plumbing fixtures (which also help save energy on water heating), and low-VOC paints, adhesives, sealants, and finishes. In addition, 84 percent of construction waste was diverted from landfill.

A significant challenge from a sustainability perspective, and a recurring issue in the hospitality sector, was the availability of sustainably sourced materials in the quantities needed for such a large hotel, says Brandon Smith, studio manager at Meyer Davis. The issue was especially acute for salvaged materials because they're usually available only in smaller amounts and what's available varies in quality and appearance. Much of the wood used at 1 Hotel South Beach comes from Colorado's beetle-killed pine.

Minimizing the use of plastics and synthetics presented another challenge typical for the sector. Examples of strategies used at South Beach include selecting fabrics that combine natural and recycled materials with durability and equipping each room with a filtered water station to eliminate plastic bottles. Hotel operations prioritize environmental responsibility with eco-friendly cleaning products, organic linens and hemp mattresses, clothes hangers molded from recycled paper, bikes and electric cars for guests' use, and support for environmental and social initiatives, such as paid volunteer days for staff and an "Earth Day Every Day" advocacy campaign.

"1 Hotel celebrates nature while encouraging sophisticated travelers to live well, do better, and connect with the world around them," says Smith. As a testament to the success of that encouragement, 40 percent of the hotel's guests report that their stay has influenced their sustainability practices at home. Integrating the seemingly paradoxical values of luxury and environmental consciousness has also created a strong flow of opportunities for the architects involved, and Smith predicts that "the luxury of enough" will form part of a growing trend toward improved sustainability across the hospitality sector.

Design principle: Prioritize the most effective strategies.

Rooftop pools do double-duty as an amenity and reducing the solar load for the building.

Image provided by: Kobi Karp Architecture & Interior Design

1 Hotel South Beach project information

Location
Miami Beach, FL

Completion date
2015

Project area
1,045,000 sf

Construction cost
$200 million

Certification
LEED Silver

Owner
Starwood Capital Group

Architect of record
Kobi Karp Architecture & Interior Design

Interior architect
Meyer Davis Studio

General contractors
Plaza Construction; First Finish

Concrete contractor
Alternative Constructors

Civil engineer
Kimley-Horn and Associates

Structural engineer
Desimone Consulting Engineers

MEP consultant
Steven Feller P.E. Consulting Engineers

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Drapery workshop
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TGA Design

Design principle: Unlock the existing building's potential.

The design team was able to deliver improved air quality for guests by optimizing the existing HVAC system with high-efficiency chillers and boilers.

Image provided by: Kobi Karp Architecture & Interior Design

References & resources

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Additional AIA resources

- The 2030 Commitment
- Healthier Materials Protocol
- COTE® Top Ten Awards
- Architects Guide to Building Performance
- Modular and Off-site Construction Guide
- Conducting Vulnerability Assessments
- Deep Energy Retrofits: An Emerging Opportunity

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