Impact *by* Design

2017

Sustainable Performance,
Environmental Impact,
Design Innovation

Gensler

> **The sustainable performance of Gensler's project work last year alone is poised to keep nearly 11 million metric tons of CO2 out of the atmosphere every year.**

A 2014 renovation of the 140-acre Sterling and Francine Clark Art Institute in Williamstown, MA, includes reservoirs, low-flow plumbing fixtures, site irrigation, and a cooling tower. Gensler served as executive architect and sustainability consultant for a series of projects in collaboration with Tadao Ando Architect & Associates (design architect for the Clark Center and Stone Hill Center), Selldorf Architects (renovation architect for the Museum and Manton buildings), Reed Hilderbrand (landscape), and Cooper, Robertson & Partners (master planning).

Gensler's diverse community of professionals is united by a common purpose—a drive to create a better world through the power of design. We believe every Gensler project is an opportunity to make a contribution to our world by enhancing people's experience in the places, spaces, and communities we design; and by having a positive impact on the environment.

To be a successful purpose-driven firm, we need to measure our impact in order to understand how to improve it. That's why we put together this annual document, ***Impact by Design 2017.*** Our goal is to have a transparent discussion about our projects and how we are affecting energy usage and CO2 emissions, construction and materials waste, water and air quality, and human health and well-being.

With this report, we hope to inspire and inform positive change to improve the performance of the built environment. Our goal is to help designers, clients, real estate professionals, and policymakers leverage design and technology solutions to improve sustainable performance regardless of project scale or type.

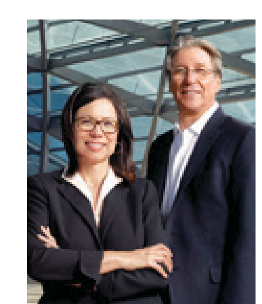
As a leader in the design and architecture profession, we see it as our responsibility to stay at the forefront of these conversations. Our work speaks for us and its impact demonstrates our commitment. As we seek a more sustainable and resilient built environment, we also recognize the power of collective impact as an industry and community. We stand alongside the voices of our peers and partners in this pursuit and continue our commitments to the Paris Pledge for Action, the Architecture 2030 Challenge, and Climate Week NYC.

We are proud of the positive impact of our work. As you will see in this report, the sustainable performance of Gensler's project work last year alone is poised to keep nearly 11 million metric tons of CO2 out of the atmosphere every year. That's huge—more than any other design firm on the planet.

But we also know that we can do much more. As we look to the future, we are focused on capturing better data from our projects to more effectively track our work. And we are increasing our use of post-occupancy reviews to understand the actual energy impact of our work.

This document is for our clients, our people, and our communities. In addition to our metrics, we include project examples, varying in size and type, to demonstrate ideas and concepts that can be used to achieve sustainable design. We are also excited to share our **"Guide to Making an Impact,"** a roadmap to help navigate all the different ways a building or space can make a difference.

We are thrilled to share this information and invite you to join this important dialogue. Together, we will create a better, more sustainable world through the power of design.



Diane Hoskins FAIA, IIDA, Co-CEO
Andy Cohen FAIA, IIDA, Co-CEO

Introduction:

Designing for Impact

Impact by Design 2017 is Gensler's second annual publication analyzing the sustainable performance of our work. Here, we provide a transparent look at the energy performance and the carbon impact of our projects.

In addition to an analysis of our work throughout calendar year 2016, the report includes a broad analysis of how new innovations in design, engineering, and technology are improving the sustainable footprint of the global built environment. Interviews with global leaders in engineering and sustainable design formed the basis for our review of current and future sustainable design strategies.

In **"Sustainability in Action,"** we spotlight recently completed Gensler projects that exemplify sustainable design in action. Our goal is to promote broader awareness about the environmental impact that buildings have on the world, and to contribute to conversations about the leadership role that the architecture, engineering, and construction industries can play in global efforts to answer the challenges posed by climate change.

When selecting materials, it is important to evaluate where they come from and to seek innovative, environmentally preferable solutions. At Boston Consulting Group in New York City's Hudson Yards, materials made from salvaged/recycled content reuse waste products that would otherwise have been sent to landfills, saving costs while also adding character.

How Buildings Impact the Environment

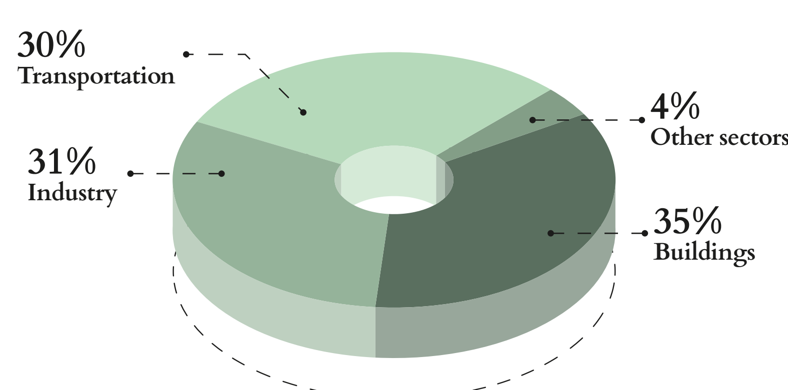
The spaces that we design and build today will create a better environment tomorrow.

Given the scale of the built environment and current projections for urban development in the future, the opportunity for positive change is immense. The construction, operation, and maintenance of buildings is responsible for over one-third of global energy use. Building materials themselves also carry a significant carbon impact—a building's embodied energy is roughly equivalent to the first 30 years of operational energy, and concrete alone accounts for as much as 8.6 percent of global CO_2 emissions.

To truly lessen the impact of the built environment, we must constantly search for new and more efficient solutions to the design, construction, and maintenance of our buildings and cities. The opportunity is huge, but so is the challenge. It is estimated that we need to reduce these greenhouse gas (GHG) emissions by more than 80 percent by 2050 to keep global temperatures from rising 1.5 degrees Celsius (the internationally agreed upon upper threshold for temperature rise). This is a lofty but achievable goal, one that can be realized through cooperation between the many players—from designers and engineers, to owners and tenants—who construct and steward the built environment.

Energy consumption by sector

Buildings are a major end-use in global energy markets and need to be a strong component of any country's plan to save energy.



SOURCE: International Energy Agency, 2013

A call for transparency, better data

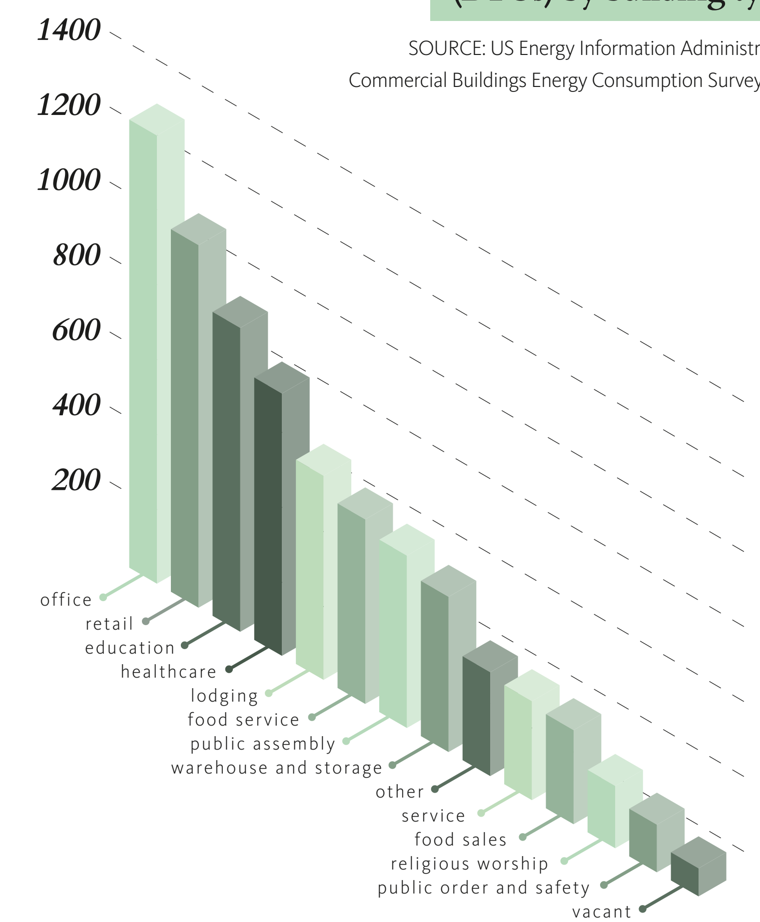
The first step, we believe, is more transparency: a lack of energy performance data on building projects from around the globe has inhibited the industry, and researchers more broadly, from quantifying the aggregate impact made by sustainable buildings.

So we're starting with ourselves. Gensler designed nearly a billion square feet of space in 2016, from workplace interiors to sports stadiums and mixed-use towers. As designed, we estimate the operations and maintenance of these buildings will contribute 50 percent less CO_2 into the atmosphere per year than a similar portfolio of projects would have emitted in 2009, when Gensler signed on to the AIA 2030 Commitment. This is a net reduction of roughly 11 million metric tons of CO_2 annually.

We want to do better; we need to move faster. And while there is no silver bullet, single technology, or engineering innovation that will make the difference, the myriad innovations in design, construction, and technology that present themselves today provide promise for significant impact.

Non-residential energy use (BTUs) by building type

SOURCE: US Energy Information Administration, 2012 Commercial Buildings Energy Consumption Survey, May 2016



Cities leading the way

Cities around the globe are where the action is. Urban areas currently contribute over 70 percent of global CO_2 emissions and over 80 percent of global GDP and economic output, while taking up only 2 percent of global landmass. As existing and new cities prepare to accommodate more than one billion new urban dwellers by 2030 (and another billion by 2045), municipal leaders must continue to find innovative planning and design solutions to ensure that they can meet the basic water, energy, food, and services requirements that make cities livable.

Based on our experience as a global firm working in major cities around the globe, we know that forward-looking building codes drive new innovations in sustainability and energy efficiency, and that massive opportunities exist to continue pushing the envelope in this area.

Urban areas currently contribute over 70 percent of global CO_2 emissions and over 80 percent of global GDP and economic output, while taking up only 2 percent of global landmass.

Viewed holistically, the growth of global cities presents businesses, civil society organizations, governments, and communities with significant opportunities to experiment with forward-looking solutions that promote sustainable economic growth and everyday urban resilience.

Recent trends suggest cause for optimism—the IEA found that global greenhouse gas emissions have fallen or stayed flat during three consecutive years of economic growth. This is the first time in modern history when greenhouse gas emissions have not risen during a time of economic expansion, suggesting that the world may be on track to meet or surpass the Paris Agreement's target of reaching peak emissions by the year 2030.

Planning for the Future

"One of the biggest challenges we face in terms of sustainable design is that the capital costs for sustainable buildings are borne by developers, but the monetary benefits are realized by tenants. We need to be clearer on the bi-directional economic benefits of creating better buildings. The property itself will be worth more if it has free or reduced cost energy built into it."

JOHN FULLERTON
FOUNDER + PRESIDENT, CAPITAL INSTITUTE

John Fullerton is globally recognized for his views on green economic development, sustainable finance, and the regenerative economy. He is the author of *Regenerative Capitalism: How Universal Principles and Patterns Will Shape Our New Economy*, as well as the widely syndicated *Future of Finance* blog.

We interviewed a diverse range of innovators and experts from outside of Gensler about the challenges and opportunities surrounding sustainable design today. Leading thinkers from academia, engineering, architecture and design, and finance offered their insights into the future of sustainability in the built environment—and the steps needed to realize our vision of a more sustainable world powered by great design.

Continuing to drive the sustainable transformation of the built environment forward will require proactive engagement from policymakers, real estate professionals, designers, and organizations at different scales. This will require new approaches to the process, design, materiality, and engineering of the spaces in which we live, work, and play. Designers, architects, developers, and civic leaders will need to embrace a more holistic approach to environmentally conscious design.

Some of this work is happening already. Cities are rediscovering their parks and waterfronts, and local governments are eager to find "resilient" solutions. Much work remains at both the individual project level and at the urban district level, where we need to rethink our approach to city planning based on the principles established by the U.N.'s *New Urban Agenda*. Sustainable design strategies continue to evolve, giving building owners, operators, and designers tools that can yield higher-performing projects.

Many of the current obstacles to broader market adoption of existing, high-impact sustainable design strategies can be addressed through incentives and policy changes. Efforts that make achieving ambitious sustainability goals also cost competitive via conventional construction make a huge difference. Developers and real estate professionals can curb some of the current concerns surrounding the extra investment it takes to incorporate energy and water efficiency into their projects by developing strong industry consensus around the long-term value-add of sustainable design solutions.

Designers must lead the way in terms of creating innovative, cost-effective solutions to the environmental challenges the industry currently faces. The AEC industry needs to get much better about working together to measure our collective impact and studying the market obstacles that make broader, wide-scale adoption difficult.

Organizations must also play a significant role. Large and small, companies must make decisions around how the built environment fits into their corporate social responsibility efforts and continue pushing the envelope to whatever extent is possible.

What you can do today

Some of the most immediate impact we can make on the sustainability of our environments happens at the scale of interiors, organizations, and even individuals. Basic decisions and adjustments to the office policies, from commuting to dress codes, are easy to implement with potential cost and energy savings to be gained, particularly when aggregated to the level of an organization or community. Some of these include:

Composting & Recycling. Better communication of proper recycling policies, and placing a food-composting option alongside trash and recycling, help divert unnecessary waste from landfills. For example, in Gensler's Costa Rica office, more than 1,300kg of food waste is composted every year to be used in an on-site organic garden. Clear, intuitive signage is key in these situations to help people quickly understand the right way to dispose of their waste.

Commuting & Transit. Working at an office near widely accessible public transportation is an ideal way to minimize emissions related to daily commutes, but in areas where this is not an option, several alternatives exist. Simple solutions like ample bike storage, on-site showers, and helping coworkers to carpool can bring down an office's carbon impact significantly.

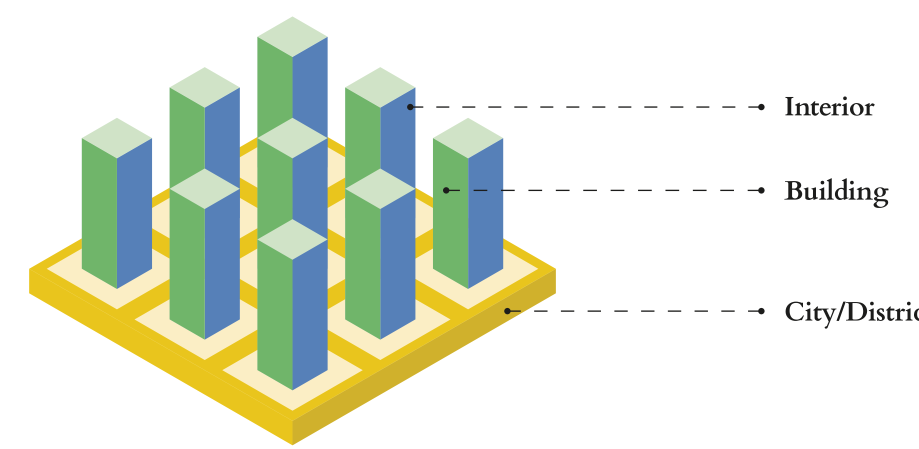
Office Dress Codes. Policies surrounding summer dress codes can positively impact an organization's heating and cooling strategies, saving money and reducing emissions related to HVAC systems by allowing interior temperatures to stay within a range that adjusts with exterior temperature instead of a set number at all times.

Flexible Work Hours. Creating policies to support flexible working hours and virtual collaboration can cut down on the number of trips an organization's workforce needs to make each week commuting to and from an office. Even if employees still come in every day, allowing them to adjust commuting times earlier/later to avoid peak hours can have an impact—not only sustainably, but also on their well-being.

For further inspiration, this report includes several case studies demonstrating the aggregated impact that specific design strategies are having on recently completed Gensler projects. Following these case studies, our **"Guide to Making an Impact"** profiles an additional suite of strategies focused on how design and engineering solutions can be leveraged to improve sustainable performance at any scale, from an interior to a city.

Scales of Impact

There are significant opportunities for impact at every scale, from the individual to the scale of entire districts, neighborhoods, and cities.



"Energy modeling technology has advanced by leaps and bounds. A decade ago, it would have taken months to do the kind of comprehensive modeling that we can do in just a few hours today. The models we build today are more definitive, easier to create, and we can put them together during the initial phases of the design process."

STEVE STRAUS
PRESIDENT, GLUMAC

As one of the world's foremost authorities on net-zero energy buildings, Steve Straus and his firm are on the leading edge of the green building industry. His firm's Shanghai office recently became the first project to achieve Petal certification from the Living Building Challenge in Asia.

Gensler's Approach to Sustainable Design

> "As more cities and local governments enact energy reporting policies, we will see a huge shift in improved metrics tracking, and increased adoption of holistic sustainable building strategies in both new construction and repositioning projects."
>
> **KATIE MESIA, AIA, LEED AP BD+C**
> REGIONAL DESIGN PURPOSE LEADER, GENSLER

As long-term proponents of sustainable design, we know that a sustainable approach to design preserves our planet's resources and produces results that matter to our clients: reduced energy and operating costs, brand advantages, longer property life cycle, enhanced human performance, and overall better quality of life.

While this report focuses largely on energy savings to reduce the planet's carbon footprint, there are myriad additional strategies that can be employed for projects of any scale or purpose. The best way to identify and leverage the strategies appropriate to each situation is to start conversations early. We work closely with clients from the pre-design stage of every project to identify opportunities that achieve synergies across disciplines and building systems.

This process enables design solutions that are holistic, resilient, and regenerative. It supports high-performance, cost-effective project outcomes through an early analysis of the interrelationships among systems.

Design considerations

Community
Helping vibrant, resilient communities, economies, and livelihoods emerge over time

Well-being
Creating environments that resonate with the human soul–uniting mind, body, and spirit

Ecology
Protecting, utilizing, and enriching our natural resources by enabling better business and a better world

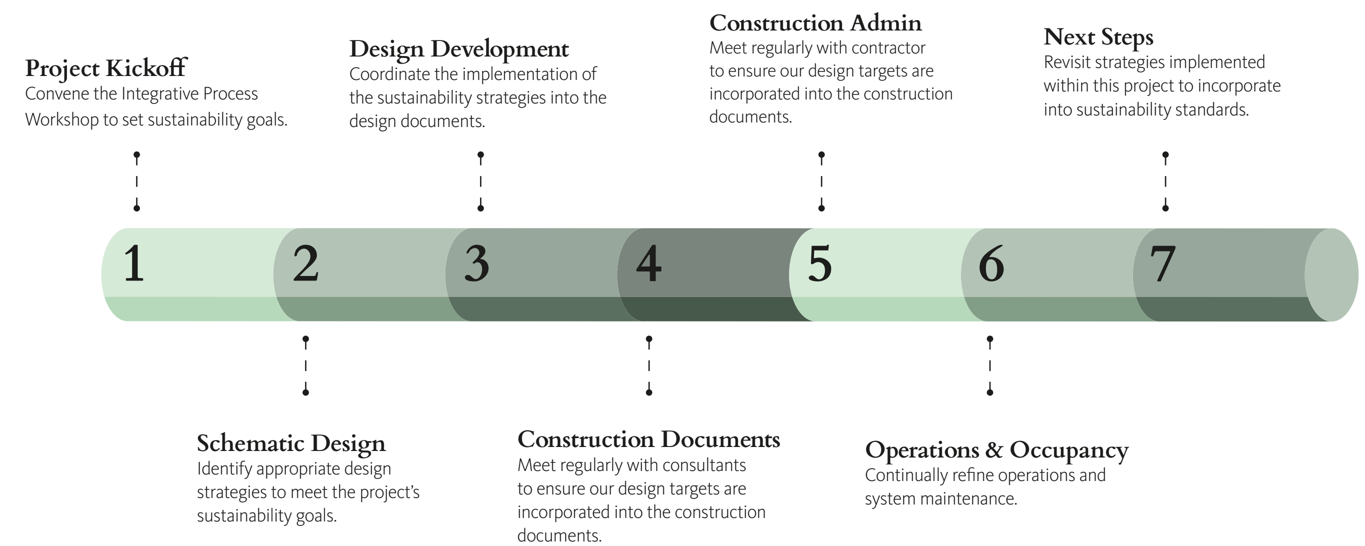
Materials
Selecting and using materials to enhance wellness, performance, and long-term value

Water
Protecting and enhancing water supplies worldwide to improve quality of life

Energy
Energizing the future by lowering demand and increasing renewables to achieve net-zero carbon

Sustainability at Every Step

Incorporating sustainable goals and milestones at every step of the design process is key to achieving performance gains.



The needs of our clients push us forward

We seek to push our clients and partners to deliver the most sustainable, impactful projects possible in every scenario. But our clients also push us to ever high levels of performance and experience. It is that productive partnership that often informs our most sustainable and resilient design solutions.

Our clients are seeking solutions that are simple, easy to maintain, and beautiful in their place. They want to evolve their brands to meet changing demographics. Many are asking for design solutions that are net-zero energy and water, and some are pursuing net-positive. They are asking for our help to create resourceful workplaces that increase wellness, innovation, and productivity.

Our clients are learning how to balance global and local, and how to optimize performance with resilience to become more adaptable and responsive to changes. We are responding with accurate assessments of context, and scenario planning enables design responses that increase resiliency with appropriate technical and natural systems. New metrics and measures of performance motivate resilient behaviors. In conjunction with passive systems and local renewable energy, water and food sources increase adaptability.

An increasing number of business leaders are integrating principles of ecology and sustainable design into their business models. Our task is to understand our clients' best interests and to apply sustainable design principles in ways that support their goals. To do this, our designers are investigating how new developments in sustainable technology can be incorporated into project work to yield lasting, measurable results.

1. Measuring Our Impact

An analysis of the energy performance of Gensler's 2016 project portfolio

"The market is increasingly recognizing the economic as well as environmental and social benefits of sustainable design solutions. We must continually seek better and broader ways to measure and minimize the climate impact of the built environment—from energy usage to a growing focus on materiality, life-cycle cost, and renewables."

KIRSTEN RITCHIE, PE, LEED AP O+M
PRINCIPAL, DIRECTOR OF SUSTAINABLE DESIGN, GENSLER

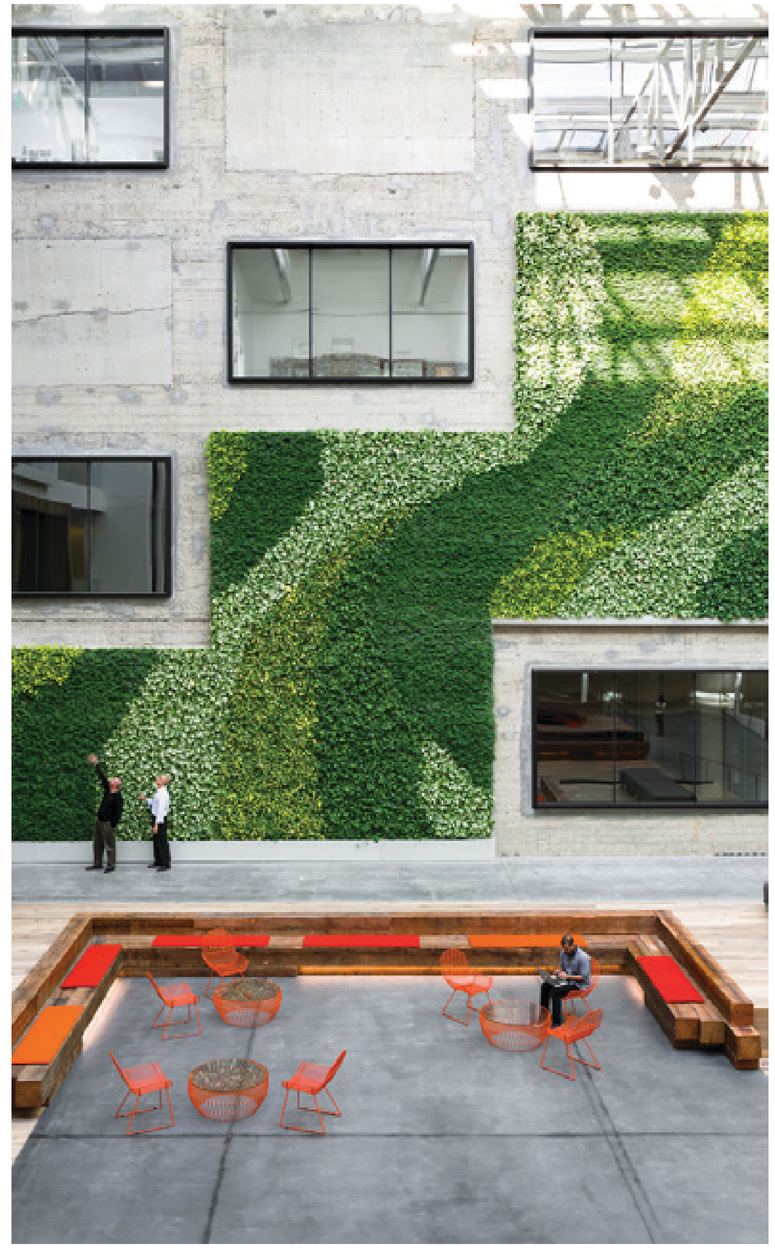
For a Confidential Energy Client's headquarters, strategically placed artwork reinforces a cultural commitment to sustainable operations and energy conservation.

Performance of Our Projects

As a signature of the Architecture 2030 Challenge, Gensler has committed to ensuring that every one of our projects is carbon neutral by 2030. The Architecture 2030 Commitment aligns with the Paris Agreement's 2030 deadline for reaching peak global emissions, and it is one of Architecture, Engineering, and Construction (AEC) industry's best benchmarking tools for measuring our progress on climate change mitigation. To remain consistent with the standards established with this ongoing industry-wide initiative, we measured the aggregate sustainable impact of our 2016 projects against the US Energy Information Agency's 2003 Commercial Buildings Energy Consumption Survey (CBECS 2003) and the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE 90.1-2007).

Gensler's 2016 projects are designed to offset 11 million metric tons of CO2 every year.

The energy footprint of our 2016 work is immense: Gensler's 2016 projects are designed to offset 11 million metric tons of CO2 every year compared to CBECS 2003 averages. Working across 126 countries with 2,925 clients, our completed projects include a variety of sustainable, high-performance strategies aimed at reducing energy use. To document the collective energy performance of our projects, we analyzed all available data on designed Energy Use Intensity (EUI) for building projects, and Lighting Power Density (LPD) for interiors projects. We then calculated baseline energy usage estimates comparable to CBECS 2003 (for new buildings) and ASHRAE 90.1 (for interiors) for each project.



At 888 Brannan in San Francisco, a multilevel atrium flooded in natural light features a geometric green wall. One of the benefits of green walls is that they can aid in reducing noise levels, which has been shown to have impact on employee energy levels, well-being, and task accuracy.

The Tower at PNC Plaza is a 33-story corporate headquarters with a design that marries pragmatism with innovation. The tower is certified LEED Platinum and features passive ventilation systems, solar chimneys, and a fully operable double-skin façade, a first in the United States.

On the whole, our portfolio represents approximately a 50 percent energy savings compared to CBECS 2003. The industry average performance for 2016 was a 42 percent improvement over baseline, according to the AIA's most recent published report. While these building performance averages represent a significant improvement for both Gensler and the industry as a whole, significant progress still needs to be made to meet the more aggressive goals agreed to by both the industry and the international community through initiatives such as the Paris Agreement. The industry's goal is to outperform the CBECS 2003 by 80 percent by the year 2020.

Importantly, we can—and will—continue to achieve our goals of energy reduction and emissions, not just by reducing the energy usage of our designed work (on which this report is focused), but also through the increased use of renewable energy to provide energy to our buildings. As the industry continues to push toward a broad goal of buildings with a net-zero impact on the environment by 2030, the increased use of renewables is expected to rise as energy needs fall, meeting in the middle.

How much is 11 million metric tons of CO2?

The scale of our projects' CO2 emissions savings is equivalent to:

3.2 years of carbon emissions from a **coal power plant**

2.34 **million passenger vehicles** driven for one year **(or 26.5 billion miles driven)**

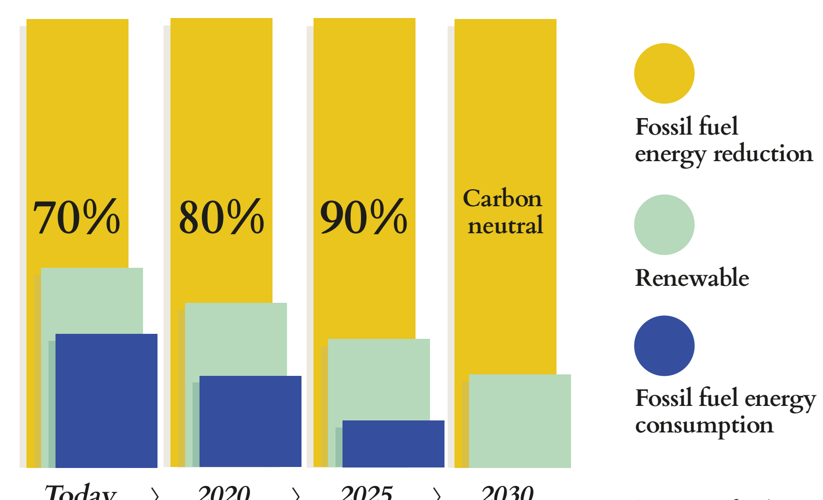
1.6 **million homes** provided with electricity for one year

10 **million acres of US forests** (equivalent carbon sequestration)

SOURCE: US Environmental Protection Agency (EPA)

The AIA Architecture 2030 Commitment

The goal: all new buildings, developments, and major renovations shall be carbon neutral* by 2030.



*Using no fossil fuel GHG-emitting energy to operate

SOURCE: AIA Architecture 2030 Commitment

Project Performance: Buildings

How we're performing

The designed Energy Use Intensity (EUI) average for our 2016 portfolio represents a 51 percent improvement over our calculated CBECS 2003 equivalent. At scale, the energy improvements compared to baseline represent a savings of approximately 15.5 billion kilowatt-hours of energy per year, or a reduction of CO2 emissions of approximately 11 million metric tons—equivalent to the annual carbon emissions generated by three coal power plants in the United States.

How the industry is performing

In 2016, data from firms participating in the AIA 2030 Commitment noted an average 42 percent improvement over the CBECS 2003 EUI baseline. Although that progress is significant, it is well short of challenge goals to achieve 70 percent improvement by 2015.

Performance goals

By 2020, the industry's goal is to achieve an 80 percent improvement over the CBECS 2003 EUI baseline. This can be achieved in two distinct ways: continuing to reduce the energy use of our buildings, and increasing the use of renewable energy sources.

703,529,294

TOTAL SQUARE FOOTAGE

73.4

AVERAGE EUI (KBTU/SF/YR)

148.9

US AVERAGE (CBECS 2003 EQUIVALENT) (KBTU/SF/YR)

50.7

% BETTER THAN US AVERAGE

15,559,000,596

ESTIMATED ENERGY SAVED (KILOWATT-HOURS/YEAR)

10,934,492

METRIC TONS OF CO2 SAVED

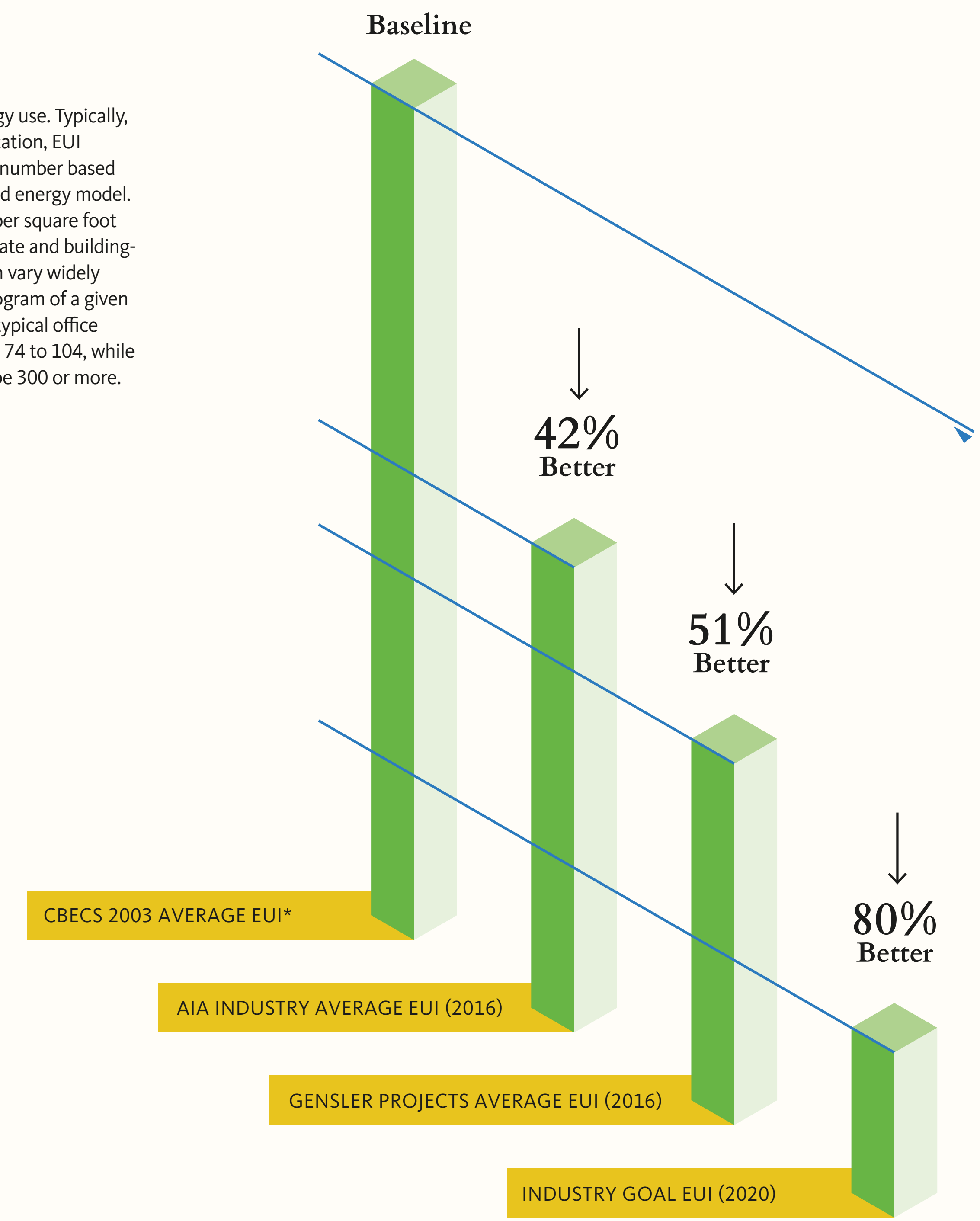
For detailed descriptions and methods for all calculations, see pages 70–71.

Measuring Our Impact

2016 Energy Use Intensity (EUI) of Gensler's Designed Buildings

EUI Explained

EUI is a measure of energy use. Typically, and as used in this publication, EUI represents an estimated number based on a building's design and energy model. It is measured in kBTUs per square foot per year. EUI is both climate and building-type dependent, so it can vary widely based on the site and program of a given building. For instance, a typical office building EUI ranges from 74 to 104, while a typical restaurant can be 300 or more.



*Weighted average based on CBECS 2003 equivalents for Gensler projects
SOURCE: AIA 2030 Commitment 2015 Progress Report

Project Performance: Interiors

How we're performing

The designed Lighting Power Density (LPD) average for our 2016 portfolio represents a 19 percent improvement over ASHRAE 90.1-2007 standards. At scale, the energy improvements compared to baseline represent a savings of approximately 173 million kilowatt-hours of energy per year, or a reduction of CO2 emissions of approximately121,000 metric tons—equivalent to taking 25,500 cars off the road for a year.

Performance goals

The industry's goal for LPD is to achieve a 25 percent improvement over baseline. As with EUI improvements, this can be achieved in two distinct ways: continuing to reduce the energy use of our buildings, and increasing the use of renewable energy sources.

264,332,663
TOTAL SQUARE FOOTAGE

0.9
AVERAGE LPD (WATTS/SF)

1.1
US AVERAGE (ASHRAE 90.1-2007 EQUIVALENT) (WATTS/SF)

18.9
% BETTER THAN US AVERAGE

173,190,761
ESTIMATED ENERGY SAVED (KILOWATT-HOURS/YEAR)

121,000
METRIC TONS OF CO2 SAVED

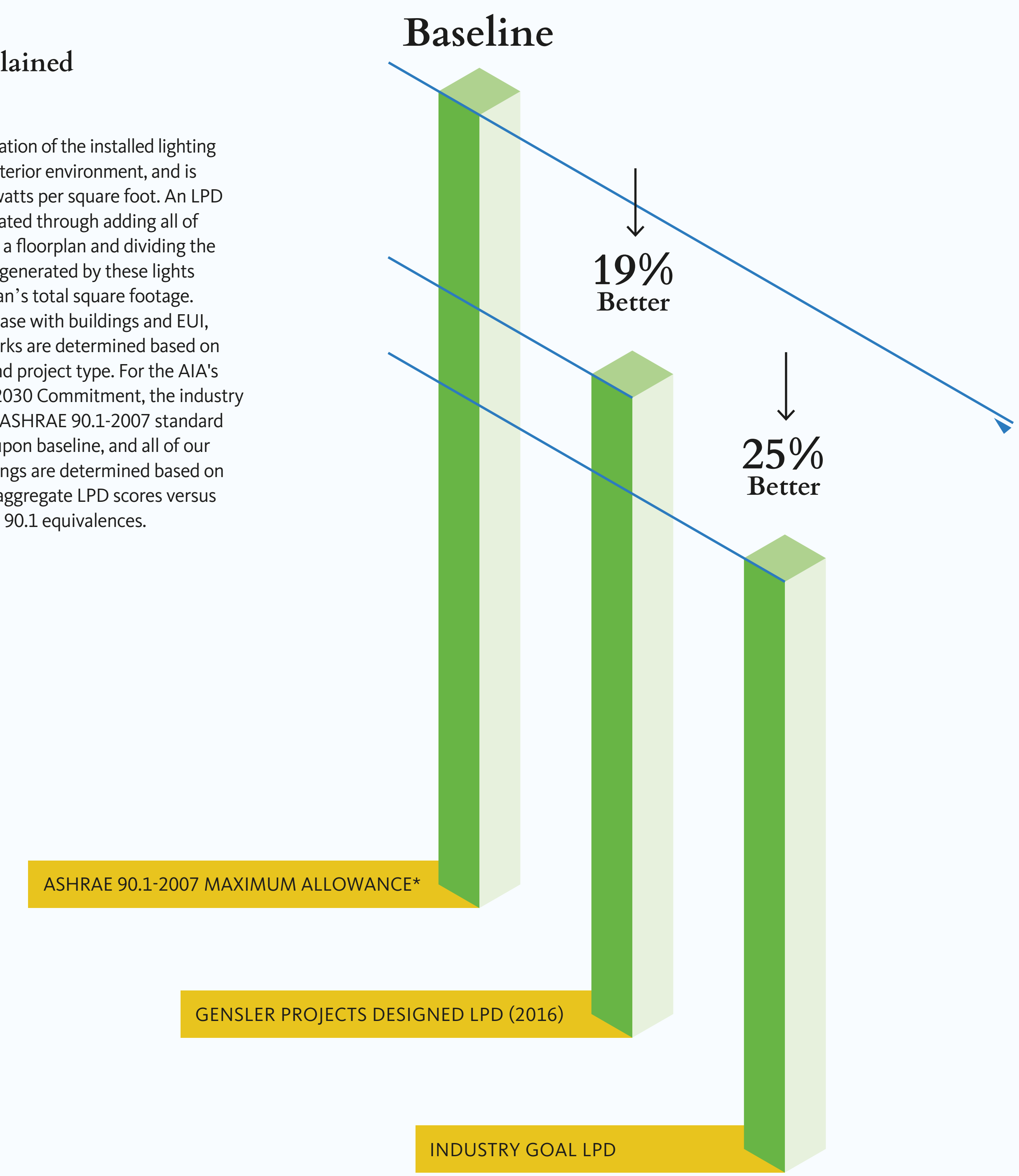
For detailed descriptions and methods for all calculations, see pages 70–71.

Measuring Our Impact

2016 Lighting Power Density (LPD) of Gensler's Designed Interiors

LPD Explained

LPD is a calculation of the installed lighting power of an interior environment, and is measured in watts per square foot. An LPD score is generated through adding all of the lighting in a floorplan and dividing the total wattage generated by these lights by the floorplan's total square footage. Just as is the case with buildings and EUI, LPD benchmarks are determined based on project size and project type. For the AIA's Architecture 2030 Commitment, the industry agreed to the ASHRAE 90.1-2007 standard as its agreed upon baseline, and all of our projected savings are determined based on our projects' aggregate LPD scores versus their ASHRAE 90.1 equivalences.



*Weighted average based on ASHRAE 90.1-2007 equivalents for Gensler projects
SOURCE: AIA 2030 Commitment 2015 Progress Report

2.
Sustainability in Action

Gensler projects that push the boundaries of sustainable performance

“The design community, in partnership with the building owners and operators, needs to address both how buildings are designed and how they are operated to achieve meaningful improvements in energy efficiency. Through the lens of climate action, even a small change to save electricity and reduce carbon emissions is consequential. It is a contribution to a global effort that is cumulative and powerful.”

RIVES TAYLOR, FAIA, LEED AP BD+C
PRINCIPAL, FIRMWIDE DESIGN RESILIENCE LEADER, GENSLER

The Tower at PNC Plaza features an innovative double-skin façade that uses natural ventilation to breathe. This feature allows the tower to operate using net-zero energy for 42 percent of working hours.

Gensler New York

New York, NY

An Internet of Things system shares information on the movement of people, providing real-time feedback on the utilization of desks, conference rooms, and collaboration areas.

Innovative performance-monitoring sensors pave the way for the next era of green building.

Performance monitoring is the future of sustainable design. Innovative green features and sophisticated sustainability strategies have a significant positive impact on the performance of buildings, but design features can only set the range of eventual outcomes—they do not determine end results. The ultimate performance of any green building will always be contingent on how well it is operated. In Gensler's New York City office, a network of sensors is used to track occupancy, energy usage, daylighting, temperature, and various indoor air quality indicators.

CO_2 Gensler New York's interior design is a 25.5 percent improvement over energy code, saving an estimated 60.5 metric tons of CO2 per year, or 6,810 gallons of gasoline.

BASELINE LPD (Watts/sf): 1.0

DESIGNED LPD (Watts/sf): 0.67

✓ LEED SILVER EXPECTED

LPD (Lighting Power Density) is measured by calculating total wattage of all lighting in a floorplan divided by the square footage, expressed in watts per square foot (watts/sf).

Architect/Design: Gensler; MEP Engineer: Robert Derector Associates; Lighting Designer: HDLC Architectural Lighting; Energy Performance: Robert Derector Mission Critical

Partners HealthCare

Somerville, MA

The site location, directly across from a new MBTA station, will allow employees to take public transportation. Bike lanes, storage spaces, and on-site showers will make cycling to work easier. And for those who drive, outlets for electric and hybrid vehicles will encourage more environmentally friendly driving options.

A new headquarters consolidates more than a dozen offices under one (green) roof.

With the completion of its 825,000-square-foot campus in Somerville, MA, Partners HealthCare has set a new standard for environmental sustainability in campus planning. The new campus consolidates 4,200 employees—who were once spread among 14 locations in and around Boston—within 500 feet of Boston's T Line Assembly Square station. This—along with an increased employee subsidy—encourages green transportation.

A high-performing envelope, extensive water conservation strategies, charging stations for electric vehicles, and parking for 156 bicycles further reduce the organization's carbon footprint, energy, and water consumption. Other sustainable strategies include 0.64 acres of green landscaping on the campus roofs that absorb water and lower heat absorption, plus 2 acres of photovoltaic solar arrays.

CO_2 14,177 metric tons of CO2 are saved each year, which is equivalent to the emissions produced by driving nearly 34 million miles.

BASELINE EUI (kBTUs/sf/yr): 134.8

DESIGNED EUI (kBTUs/sf/yr): 51.5

✓ LEED GOLD V4 CERTIFICATION

EUI (Energy Use Intensity) is measure of energy use, estimated based on a building's design and energy model, and expressed in kilo British thermal units per square foot per year (kBtus/sf/yr).

Architect/Design: Gensler; MEP: Buro Happold Engineering; Lighting Design: Horton Lees Brogden (HLB) Lighting Design; Energy Performance: Buro Happold Engineering, Vidaris

San Francisco International Airport

Terminal 3, Boarding Area E
San Francisco, CA

SFO's T3BAE pushes the airport's waste reduction efforts a step further, offering liquid waste stations to reduce the weight of refuse that must be removed from the terminal.

"Our sustainable design strategy is pleasant for the eyes, quiet for the ears, and odorless and clean air for the nose, all while saving for water, energy, and waste generation. Travelers coming and going from the new boarding are happy and relaxed."

SAM MEHTA
ENVIRONMENTAL SERVICES MANAGER,
SAN FRANCISCO INTERNATIONAL AIRPORT

Airports are primed to combat global temperature rise when policy-making, urban planning, and design innovations unite.

San Francisco International Airport (SFO) has established itself as an international leader in sustainability, aiming to achieve zero greenhouse gas emissions, zero solid waste, and zero net energy consumption by 2021. The renovation of Boarding Area E at Terminal 3 (T3BAE), home to United Airlines, is SFO's latest terminal project designed to contribute to its climate action goals.

In 2015, SFO reported a net emissions reduction of 5,895 metric tons. And while T3BAE was only one piece of the sustainable agenda pushed by the airport, its US EPA estimated energy savings is equal to 76 percent of the airport's total greenhouse gas reduction for the year.

CO_2 SFO's T3BAE is one of the most sustainable airport terminals in the world, saving enough electricity to eliminate approximately 4,483 metric tons of CO2 emissions each year. It aims to become net-zero by 2021.

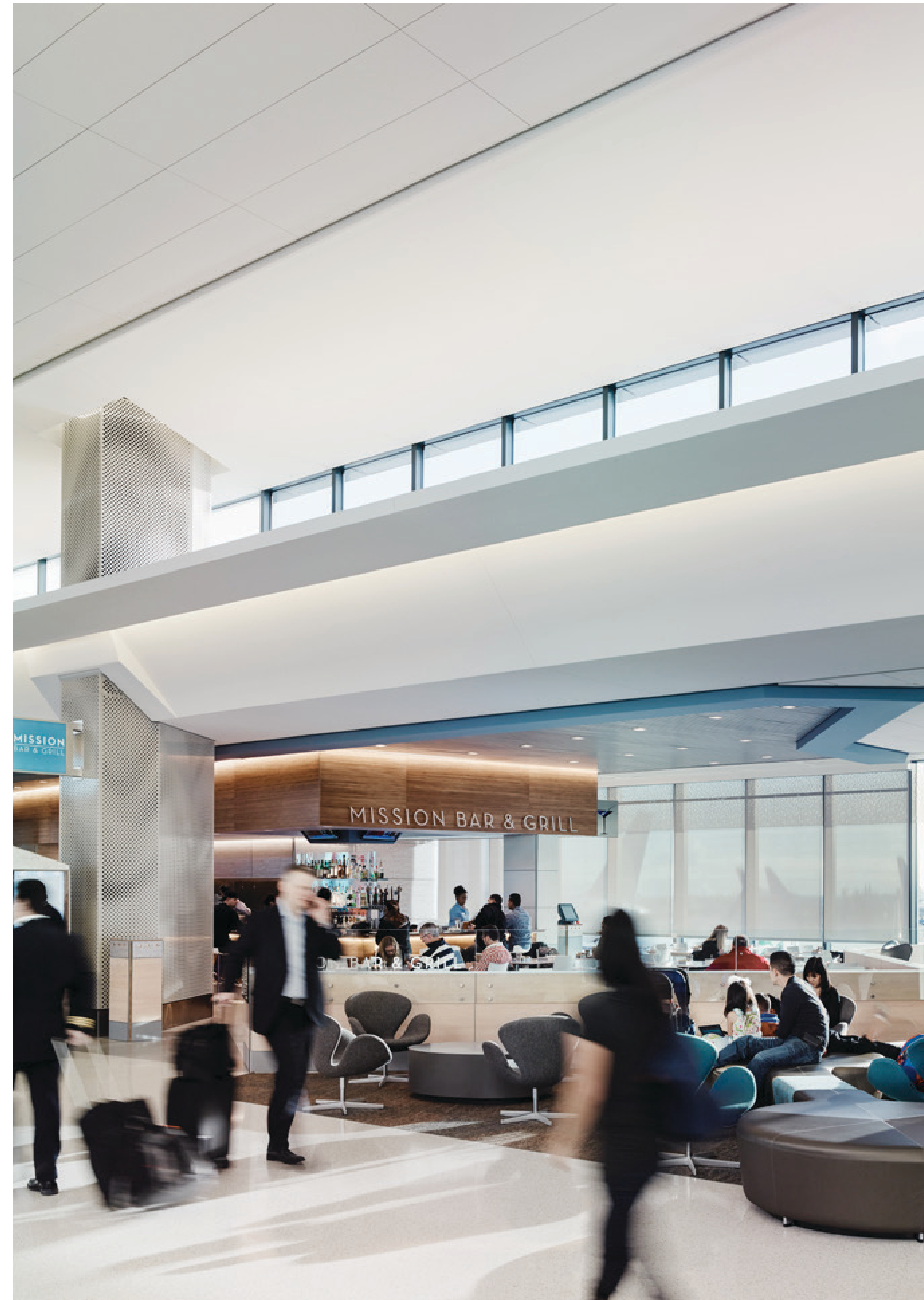
BASELINE EUI (kBTUs/sf/yr): 75.5

DESIGNED EUI (kBTUs/sf/yr): 53.2

✓ LEED GOLD CERTIFICATION

EUI (Energy Use Intensity) is measure of energy use, estimated based on a building's design and energy model, and expressed in kilo British thermal units per square foot per year (kBTUs/sf/yr).

Architecture/Design: Gensler, Associate Architects: Hamilton + Aitken Architects, Robin Chiang & Co, Energy Performance: Thornton Tomasetti; MEP: WPS Group (Design) and Spencer with ME Engineers (Build), Lighting: JS Nolan + Associates



The Westin Hotel & Transit Center

Denver International Airport
Denver, CO

The first LEED Platinum airport hotel takes sustainability to new heights.

The Westin Hotel and Transit Center is a model of the kind of civic-minded project that can create healthier communities. The project connects Denver International Airport (DEN)—the sixth-busiest airport in the United States—to the city and metro region's public transportation system, helping to decrease traffic congestion, lower air pollution, increase human health, and promote more livable and walkable communities.

During the center's construction, 10,135 tons of waste was diverted from landfills, saving approximately 17,959 tons of CO2, or the annual emissions attributed to 3,794 passenger cars. Sophisticated water-use reduction efforts save 8,138,920 gallons of water every year.

"The Hotel and Transit Center establishes a new standard for airport hotels, conference centers, and connecting urban centers with aviation services via mass transit."

KIM DAY
CHIEF EXECUTIVE OFFICER,
DENVER INTERNATIONAL AIRPORT

The building's sophisticated envelope is a driving factor for the project's overall performance, with the glass curtain wall effectively controlling heat gain and loss.

CO_2 Energy is routed away from unoccupied guest rooms, and advanced daylighting sensors and lighting controls lower the building's electricity consumption enough to save 4,556 metric tons of CO2 every year. This is roughly equivalent to the amount of CO2 produced by 673 homes using electricity for an entire year.

BASELINE EUI (kBTUs/sf/yr): 78.9

DESIGNED EUI (kBTUs/sf/yr): 67.9

✓ LEED PLATINUM CERTIFICATION

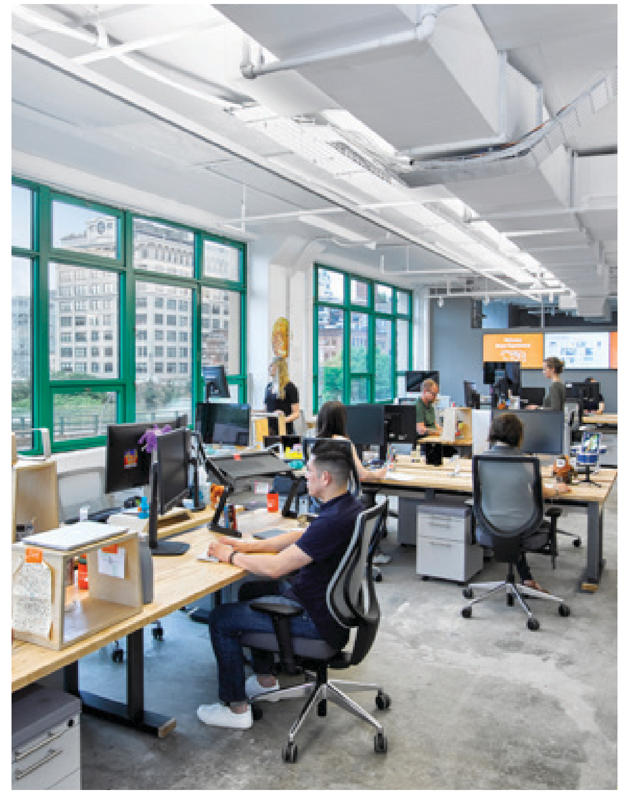
EUI (Energy Use Intensity) is measure of energy use, estimated based on a building's design and energy model, and expressed in kilo British thermal units per square foot per year (kBTUs/sf/yr).

Architect/Design: Gensler; MEP: M-E Engineers, Inc., BCER Engineering, CE Group; Lighting Design: SSG MEP; Energy Performance: Ambient Energy

Etsy Headquarters

Brooklyn, NY

The project's story is one of a kind, with a focus on sustainable, authentic, local, and reclaimed materials purchased from makers selling products on the Etsy platform.



A focus on sustainable, authentic, local, and reclaimed materials sets a new standard.

Etsy's Brooklyn headquarters, located in a reclaimed warehouse in the city's DUMBO neighborhood, was designed to be a fully interdependent, regenerative ecosystem that sets the bar for a more dynamic and robust interpretation of sustainability. More than 1,500 materials were vetted for toxic or harmful chemicals, which the company hopes will help "move the needle in the building and construction industries at large" toward a more responsible approach to the natural world. During construction of Etsy's new headquarters, 91 percent of all waste generated was kept out of landfills—or 316 tons of waste diverted to be recycled or repurposed.

> "A world based on community, shared success, commitment to sustainable operations, and using the power of business for a higher purpose … begins with our workplace."

CHAD DICKERSON
FORMER CEO, ETSY

CO_2 **Through diverted waste,** Etsy kept approximately 111 metric tons of CO2 emissions from being released into the atmosphere, which is equivalent to preventing 118,448 pounds of coal from being burned.

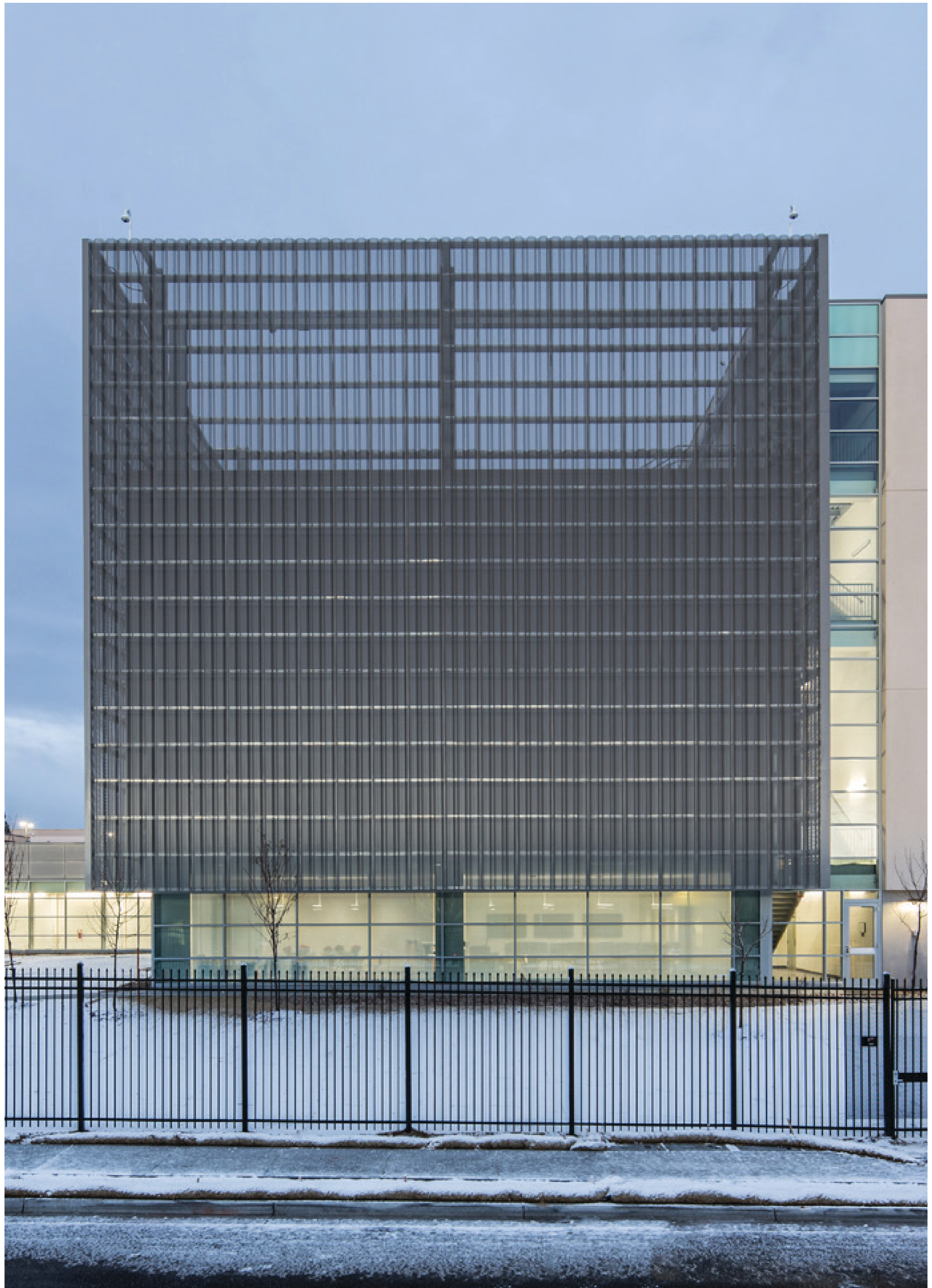
BASELINE LPD (Watts/sf): 1.0

DESIGNED LPD (Watts/sf): 0.85

✓ LIVING BUILDING CHALLENGE, PETAL CERTIFIED

LPD (Lighting Power Density) is measured by calculating total wattage of all lighting in a floorplan divided by the square footage, expressed in watts per square foot (watts/sf).

Architect/Design: Gensler; MEP: AMA Consulting Engineers, P.C.; Lighting Design: HDLC Lighting; Energy Performance: WSP



Charter Communications National Center West

(formerly Time Warner Cable)
Centennial, CO

Data centers contribute about 2 percent of global CO2 emissions.

For most people, going paperless is synonymous with reducing waste and preserving resources, but there is an environmental downside to becoming a more digital society. Data centers are the backbone of an Internet-driven economy, and they now contribute about 2 percent of global CO2 emissions. Charter Communications' recently completed National Center West data center demonstrates how sustainable design can help limit emissions related to the ongoing digitization of cultural and economic life in the 21st century.

Using innovative design features such as daylighting (something generally unheard of in data center projects) and a curtain wall at circulation paths throughout the facility, the project incorporated multiple passive design strategies to shrink its energy footprint.

The Denver area is a top choice for data centers due in part to the dry, cool air, which naturally cools the facility most of the time—greatly reducing generation requirements.

CO_2 A 25 percent reduction in EUI amounts to a saving of 1,312 metric tons of CO2 each year, or approximately 1,400,250 pounds of coal burned.

BASELINE EUI (kBTUs/sf/yr): 142.7

DESIGNED EUI (kBTUs/sf/yr): 112.5

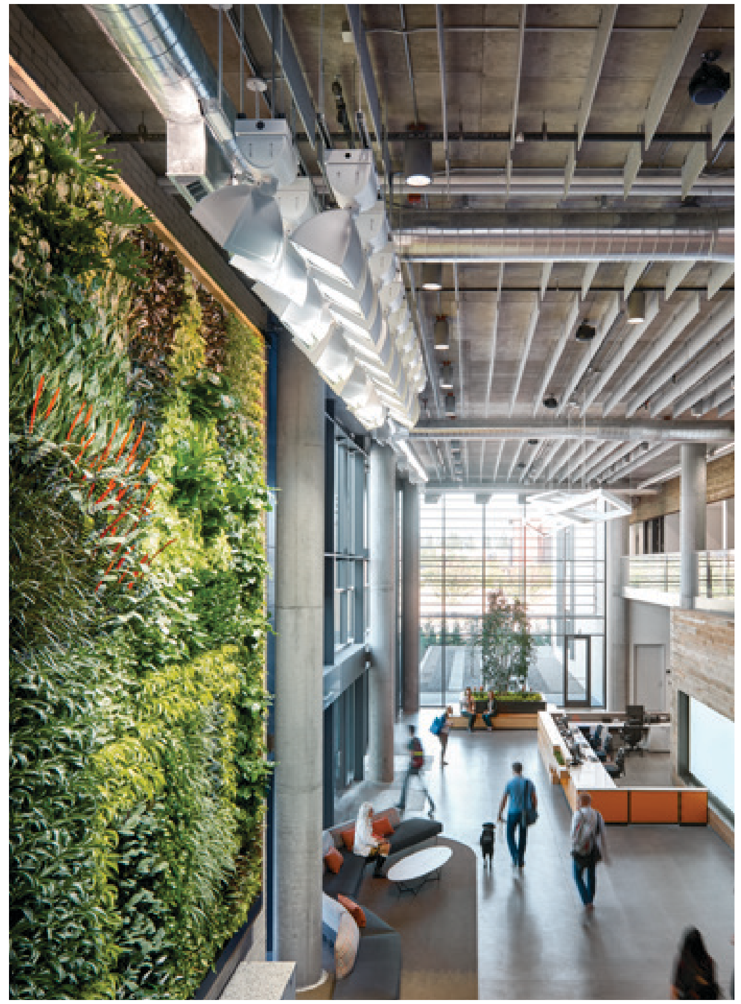
✓ LEED GOLD CERTIFICATION

EUI (Energy Use Intensity) is measure of energy use, estimated based on a building's design and energy model, and expressed in kilo British thermal units per square foot per year (kBTUs/sf/yr).

Architect/Design: Gensler; MEP: TiePoint-BKM Engineering, LLC; Lighting Design: TiePoint-BKM Engineering, LLC; Energy Performance: TiePoint-BKM Engineering, LLC

Banfield Pet Hospital

Vancouver, WA



The Banfield project uses 44 percent less energy than a project designed to code minimums. For this project, building materials—including wood, steel, and concrete—were regionally sourced. Ramps are pet friendly and encourage walking.

A focus on renewables delivers huge savings.

At Banfield Pet Hospital's headquarters, the construction and design teams focused on harnessing renewable energy sources and decreasing power consumption, water usage, and carbon dioxide emissions. Throughout construction, 75 percent of waste was recycled, keeping 750 tons from landfill disposal. Additionally, rainwater harvesting of more than 420,000 gallons annually spares potable water from toilet flushing, and regionally adapted plants reduce irrigation water use by 60 percent.

CO_2 According to the US EPA's WARM model, diverting 750 tons of construction waste from landfill is equivalent to saving approximately 667 metric tons of CO2 from emission into the atmosphere.That's enough energy to power 70.4 homes for an entire year.

BASELINE EUI (kBTUs/sf/yr): 104.0

DESIGNED EUI (kBTUs/sf/yr): 33.8

✓ LEED PLATINUM CERTIFICATION

EUI (Energy Use Intensity) is measure of energy use, estimated based on a building's design and energy model, and expressed in kilo British thermal units per square foot per year (kBTUs/sf/yr).

Architect/Design: Gensler, TVA Architects; MEP: Interface Engineering; Lighting Design: Interface Engineering; Energy Performance: Interface Engineering, Green Building Services

Glumac

Shanghai, China

"Projects that achieve this level of performance can claim to be the 'greenest' anywhere, and will serve as role models for others that follow."

STEVE STRAUS
CEO, GLUMAC

A pioneering approach pushes sustainability across a global portfolio.

Glumac Shanghai is Asia's first project to achieve the Living Building Challenge Petal certification, and has also achieved Platinum certification under LEED v4. This groundbreaking project has a net-zero energy and water usage rate and a zero-carbon climate footprint. Glumac Shanghai's materials and biophilic atmosphere optimize human health, while features like a particulate matter (PM2.5) and ambient VOC tracking app help keep the indoor air quality high in a city known for dangerous levels of air pollution. Additional sustainability features include advanced air purification systems, composting toilets, integrated photovoltaics, solar-powered water fixtures, corn-based carpeting, recycled aerogel insulation panels, radiant floor climate control, and rainwater collection.

The space is net-positive for energy, water, and carbon. It also is designed to deliver exceptional indoor air quality, with air filtering to reduce the particle count to less than one-tenth of outdoor conditions.

CO_2 Significant energy savings are projected to save 70.7 metric tons of CO2 from being emitted every year, the equivalent emissions to burning 75,000 pounds of coal or diverting 22.4 tons of waste from landfill.

✓ FIRST LIVING BUILDING CHALLENGE PETAL CERTIFIED PROJECT IN ASIA

BASELINE EUI (kBTUs/sf/yr): 86.2

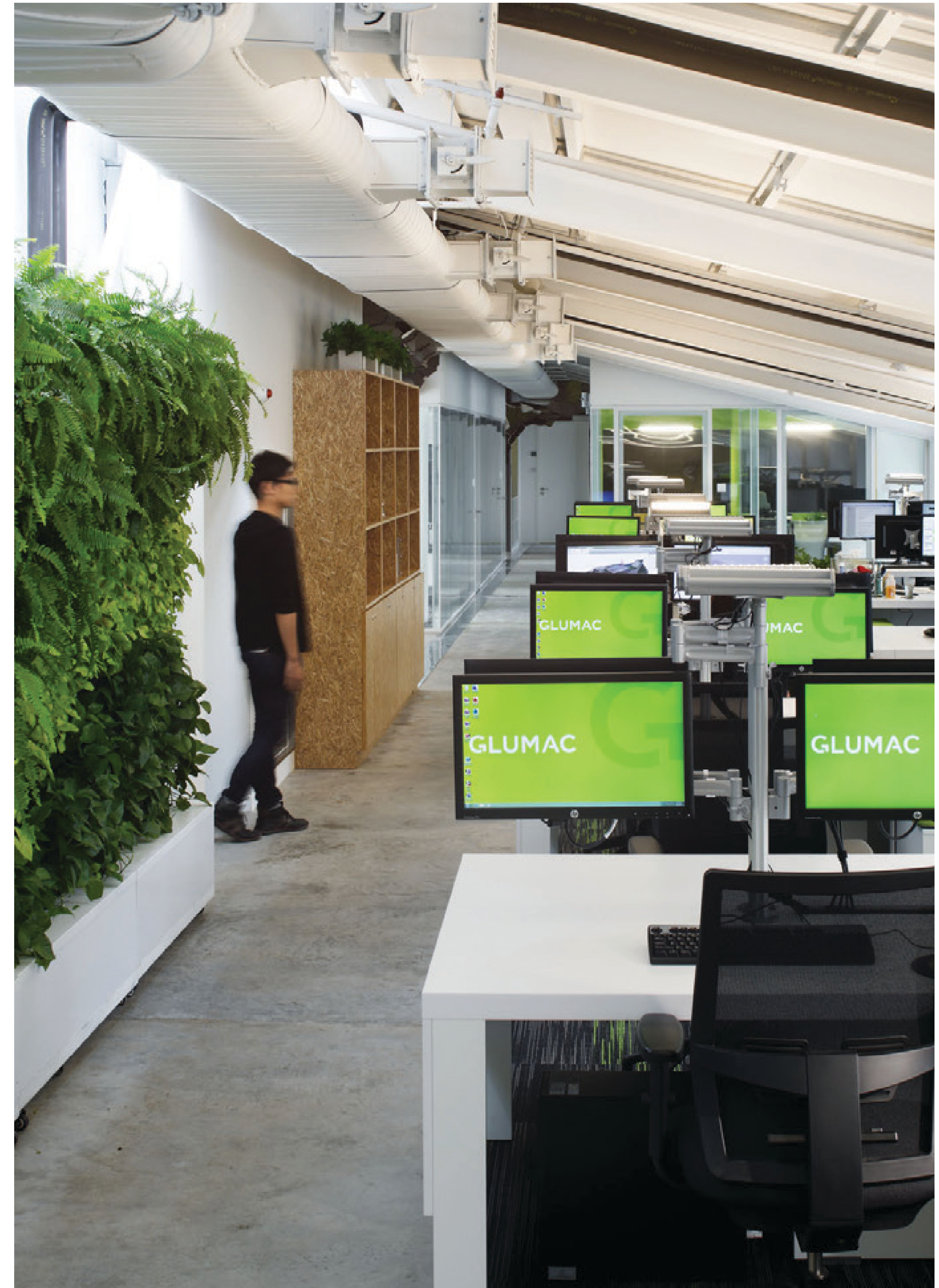
DESIGNED EUI (kBTUs/sf/yr): 33.4

✓ LEED PLATINUM CERTIFICATION

✓ WELL-CERTIFIED PROJECT

EUI (Energy Use Intensity) is measure of energy use, estimated based on a building's design and energy model, and expressed in kilo British thermal units per square foot per year (kBTUs/sf/yr).

Architect/Design: Gensler; MEP: Glumac; Lighting Design: Glumac; Energy Performance: Glumac



Houston Advanced Research Center

Houston, TX

The design employs a forward-thinking approach to water. Captured rainwater from the roof and parking lot is diverted into vegetated bioswales.

"The attention to sustainable engineering and design, and the quality of construction, allowed HARC to weather [Hurricane Harvey]... We are ready and able to stand with Houston on the long road to recovery ahead, in very large part because of our resilient building."

Lisa Gonzalez
President and Chief Executive Officer, HARC

Not-for-profit achieves high impact on a tight budget.

HARC is building a sustainable future that helps people thrive and nature flourish. Site stewardship is important, with an emphasis to preserve as much of the original site as possible. Natural and reclaimed building materials help reduce the environmental impact of a new building. Their new headquarters provides ideal balance and flexibility for employees. Offices allow researchers to focus while open areas encourage collaboration. Light-filled corridors offer a greater sense of well-being with an enhanced connection to nature and the outdoors.

The new HARC headquarters is aiming for LEED Platinum and is targeting Net Zero Energy Building standards. Gensler designed a smart building envelope that is coupled with on-site solar and geothermal energy generation to meet all of the building's heating, cooling, and electricity needs. An interactive live energy meter kiosk encourages occupants to interact with the building and learn more about building performance.

CO_2 An over 50 percent reduction in energy use intensity will save 100 metric tons of CO2 from being released into the atmosphere every year. That's the equivalent emissions to driving 240,000 passenger miles in a car.

BASELINE EUI (kBTUs/sf/yr): 41.6

DESIGNED EUI (kBTUs/sf/yr): 18.3

✓ LEED V3 PLATINUM REGISTERED

EUI (Energy Use Intensity) is measure of energy use, estimated based on a building's design and energy model, and expressed in kilo British thermal units per square foot per year (kBTUs/sf/yr).

Architect/Design: Gensler; MEP: CMTA Consulting Engineers

International Interior Design Association

Chicago, IL

Full-height windows on three exposures maximize daylight, while integrated sensors manage artificial lighting to save energy.

A transformative workplace celebrates design while achieving daylight and energy efficiency.

The International Interior Design Association (IIDA) strives to elevate the profession of interior design and lead the way for the next generation of interior design innovators. To do that, its new Chicago headquarters needed to deliver not only a great experience for employees and visitors, but also set an example for resource efficiency and sustainable performance.

The project's site was selected for the long list of walkable amenities that surround it and its great access to public transportation. Every appliance had to meet ENERGY STAR requirements to be included in the project, which also features daylight sensors for all spaces within 15 feet of its full-height windows. IIDA has also entered into a power purchase agreement to offset energy usage with energy gained from renewable sources.

CO_2 An LPD 25 percent better than baseline will save 10.2 metric tons of CO2 from being emitted on a yearly basis—the equivalent to stopping 10,907 pounds of coal from being burned.

BASELINE LPD (Watts/sf): 1.1

DESIGNED LPD (Watts/sf): 0.8

✓ LEED GOLD CERTIFICATION

LPD (Lighting Power Density) is measured by calculating total wattage of all lighting in a floorplan divided by the square footage, expressed in watts per square foot (watts/sf).

Architect/Design: Gensler; MEP: ESD Construction, Inc; Lighting: Kugler Ning Lighting Design Inc.; Energy Performance: Ebert & Baumann Consulting Engineers, Inc.

Johnson Controls Headquarters Asia Pacific

Shanghai, China

A custom façade system delivers LEED Platinum-level performance in a complex building geometry via ultra-high performing glass, insulated metal panels, and glass fiber reinforced concrete.

Creative sustainability solutions in one of the world's most populated cities.

The Johnson Controls Headquarters Asia Pacific in Shanghai is a leading example of design innovation, sustainability, and smart technology. Visitors are immersed in light via the building's five-story atrium, custom façade system, and open floorplans. A green roof mitigates solar heat on the structure, while photovoltaic panels on the roof help regulate energy usage. And a canteen and private courtyard lowers the barrier between the built environment and the environment itself.

Visitors and customers see and feel the headquarters' sustainable design and technologies directly. The mezzanine overlooks the central plant, featuring Johnson Controls' own HVAC system, air distribution products, and Distributed Energy Storage unit.

CO_2 A projected 3,413 metric tons of CO2 will be kept out of the atmosphere on a yearly basis due to the building's sustainable performance, equivalent to taking 721 passenger cars off the road for a year.

✓ CHINA GREEN BUILDING DESIGN THREE STAR CERTIFICATION

BASELINE EUI (kBTUs/sf/yr): 104.0

DESIGNED EUI (kBTUs/sf/yr): 60.0

✓ LEED PLATINUM CERTIFICATION

✓ IFC-WORLD BANK GROUP'S EDGE CERTIFICATION

EUI (Energy Use Intensity) is measure of energy use, estimated based on a building's design and energy model, and expressed in kilo British thermal units per square foot per year (kBTUs/sf/yr).

Architect/design: Gensler; MEP: Glumac; Lighting Design: LEOX

University of Kansas School of Business

Capitol Federal Hall
Lawrence, KS

Efficient windows and glazing allow for an energy-efficient space with abundant natural light and views.

Comprehensive sustainability strategies inside and out amount to significant energy and water savings.

Abundant natural light, recycled materials, and integrated sensors are just some of the key sustainable strategies employed at the new Capitol Federal Hall. An overall focus on reducing the materials needed, thus reducing the overall carbon footprint, was also pervasive. Specified low-VOC emitting materials and recycled content were used wherever possible.

Used for both the exterior and interior panel finish, the building was designed with one composite insulated precast panel, which reduced the need for a separate interior wall or furring system inside of the building. Integration of recycling centers next to trash receptacles allows users a convenient opportunity to participate in KU's recycling programs. Water usage is reduced in restrooms with low- flow fixtures. Occupancy sensors on several lighting elements and LED fixtures in many locations allow for energy-saving opportunities.

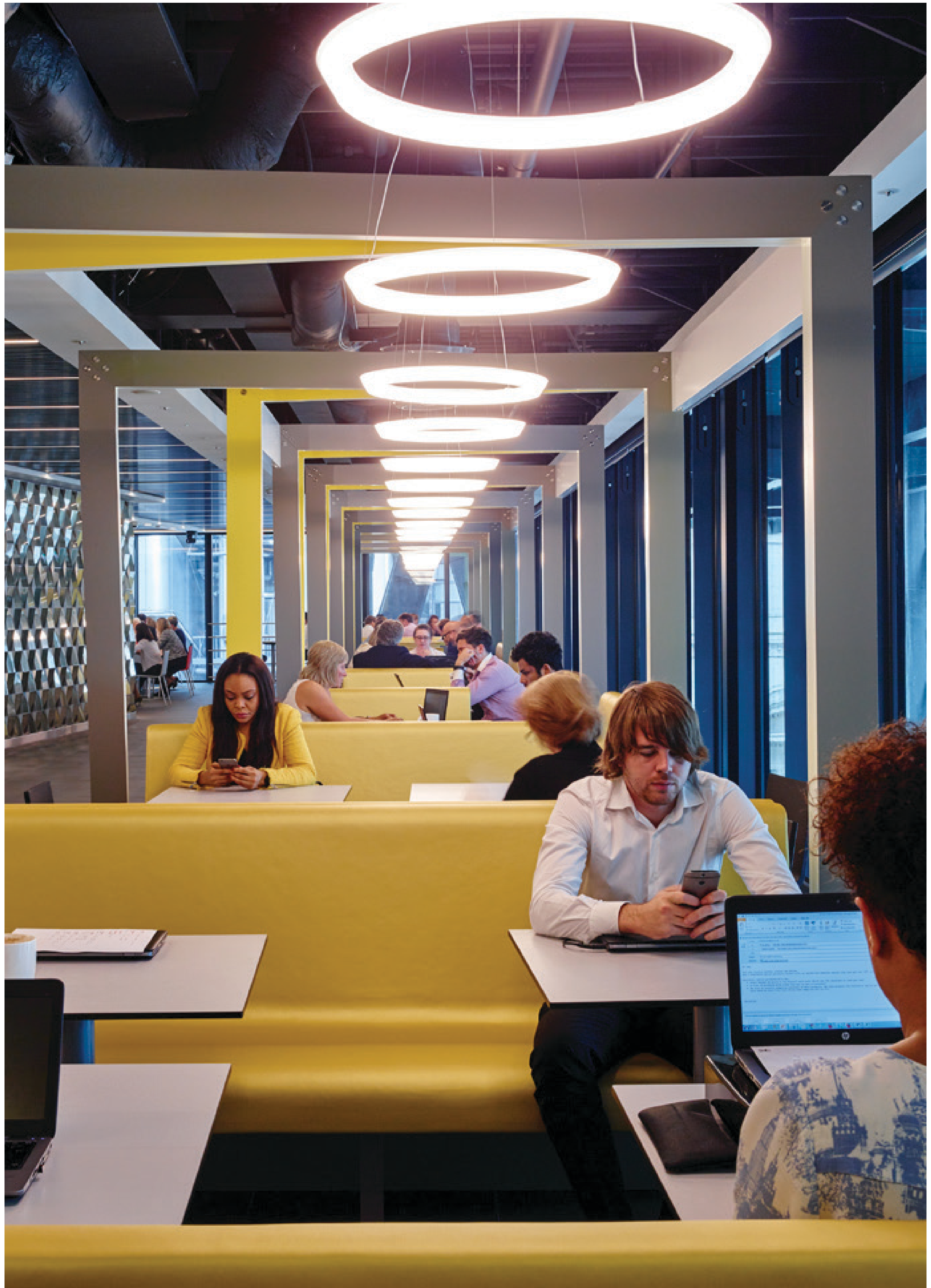
CO_2 The project is designed to save 533 metric tons of CO2 from being emitted each year, the equivalent emissions to driving 1.2 million miles by the average personal vehicle.

BASELINE EUI (kBTUs/sf/yr): 49.2

DESIGNED EUI (kBTUs/sf/yr): 33.7

EUI (Energy Use Intensity) is measure of energy use, estimated based on a building's design and energy model, and expressed in kilo British thermal units per square foot per year (kBTUs/sf/yr).

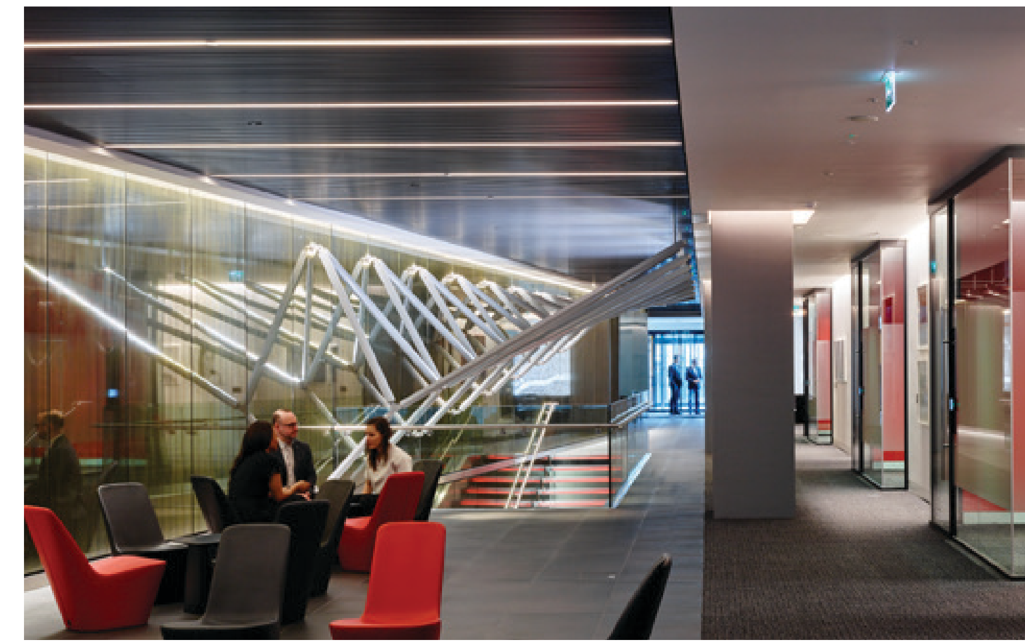
Design Architect: Gensler; Architect of Record: GastingerWalker&; MEP: W.L. Cassell & Associates, Inc.



Aon Centre

London, UK

Energy-monitoring equipment installed throughout the space allows real-time performance monitoring and optimization.



A headquarters relocation focused on a smaller footprint, energy savings, and well-being.

When Aon decided to relocate its global headquarters from Chicago to London, making more efficient use of space and resources was a key priority. Its new London headquarters reduced total square footage significantly (by more than 100,000 square feet), while housing a staff of similar size.

In addition to making more efficient use of space, the Aon Centre leverages advances in technology and construction methods to achieve resource and energy savings. Energy monitoring equipment installed throughout the building measures actual performance. Eighty percent of the building was prefabricated off-site, reducing the carbon footprint of construction and waste disposal. The result is an actual yearly energy savings of 3.6 million kWh, offsetting approximately 2,000 metric tons of CO2 emissions.

CO_2 Aon's yearly savings in their new space amount to approximately 2,000 metric tons of CO2 offset from being emitted into the atmosphere—the equivalent of taking 422 passenger vehicles off of the road for a year, or offsetting the burning of more than 2 million pounds of coal.

BASELINE EUI (kBTUs/sf/yr): 104.0

ACTUAL EUI (kBTUs/sf/yr): 89.7

✓ BREEAM EXCELLENT

EUI (Energy Use Intensity) is measure of energy use, estimated based on a building's design and energy model, and expressed in kilo British thermal units per square foot per year (kBTUs/sf/yr). Actual EUI based on measured project performance July 2015 to June 2016.

Architect/Design: Gensler; Sustainability/Lighting/MEP: ChapmanBDSP; Mechanical Engineer: Buro Happold Engineering; Technology: PTS Consulting

The Tower at PNC Plaza

Pittsburgh, PA

Passive design strategies align to set a new standard for sustainable skyscrapers.

The Tower at PNC Plaza combined numerous active and passive design strategies to become one of the greenest skyscrapers in the world. The tower operates close to net-zero during Pittsburgh's moderate spring and fall months, while achieving a 50 percent reduction in energy use overall. This represents approximately 7,083 metric tons of CO2 each year, and an estimated 92,079 metric tons by the year 2030. To accomplish a similar amount of greenhouse gas reduction, 213,182 barrels of oil would have to be kept underground over the next 13 years, or 87,162 acres of forests would need to be planted.

An innovative double-skin façade uses natural ventilation to breathe, which allows the tower to operate using net-zero energy for 42 percent of working hours.

CO_2 REDUCTION IN ENERGY CONSUMPTION REPRESENTS
7,083 metric tons of CO2 saved annually, or 92,079 metric tons by 2030.

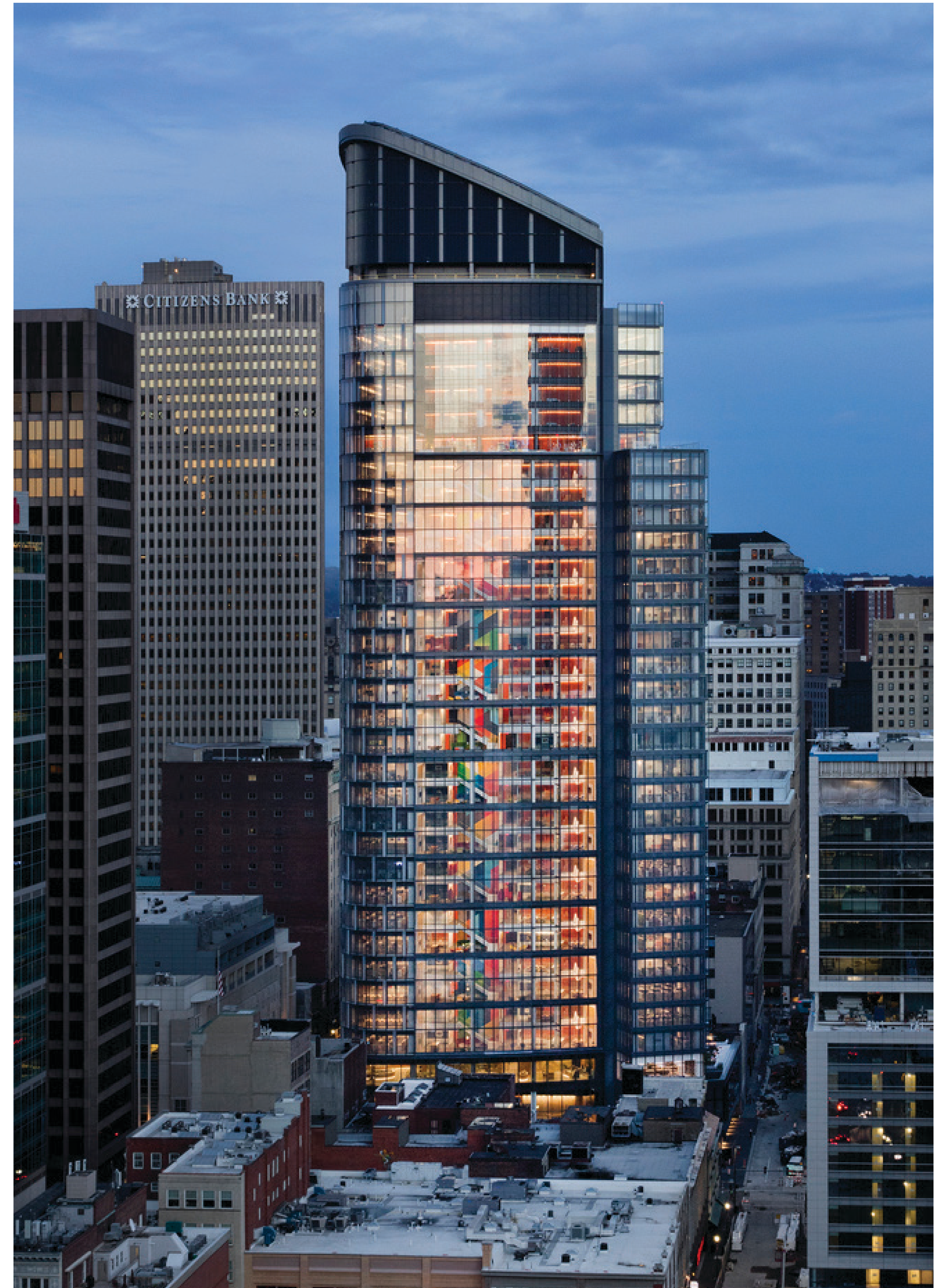
BASELINE EUI (kBTUs/sf/yr): 110.0

DESIGNED EUI (kBTUs/sf/yr): 67.0

✓ LEED PLATINUM CERTIFICATION

EUI (Energy Use Intensity) is measure of energy use, estimated based on a building's design and energy model, and expressed in kilo British thermal units per square foot per year (kBtus/sf/yr).

Architect/Design: Gensler; MEP: Buro Happold Engineering; Lighting Design: Fisher Marantz Stone, Studio i Architectural Lighting; Building Performance: Buro Happold Engineering, Studio i Architectural Lighting



3.
Guide to Making an Impact

Strategies shaping the future of sustainable design

For Turek, a general contractor headquartered in Southern California, simple, sustainable materials are assembled in a unique, unexpected way to add visual interest to an otherwise unremarkable ceiling.

"Smart buildings are going to fundamentally change the way buildings are managed and operated. Changes in technology and the nature of work are creating new opportunities to develop more sustainable buildings."

FIONA COUSINS
FELLOW + PRINCIPAL, ARUP

Fiona Cousins leads the sustainability team of Arup's New York office. She is a LEED Fellow and served as the chair of the New York Chapter of the USGBC (Urban Green) from 2008–2009 and as chair of USGBC in 2016. She co-authored *Two Degrees: The Built Environment and Our Changing Climate*.

Impact at Every Scale

To identify strategies with the greatest potential impact, we conducted interviews with experts in sustainable design and engineering. From those discussions, we generated a short list of strategies and technologies in which experts see potential to improve the performance of our buildings and spaces.

We broke these down by scale to inform targeted conversations depending on the situations and types of projects we (as designers) and our clients (as the users, developers, owners, managers, and stewards of the built environment) are currently facing. As these strategies reflect distinct situations, each offers different challenges and opportunities.

Conversations at each scale also have the opportunity to grow to impact broader initiatives and change. At the scale of behavior, communities and organizations not only can change their own relationship with the built environment, but can also revise the expectations they bring to the built environment as a whole—influencing the ways that future environments, buildings, and cities are built. Movements toward greater sustainable performance and LEED certification show this power—the market recognized the importance of improving performance, and as tenants were willing to pay a premium, LEED adoption soared.

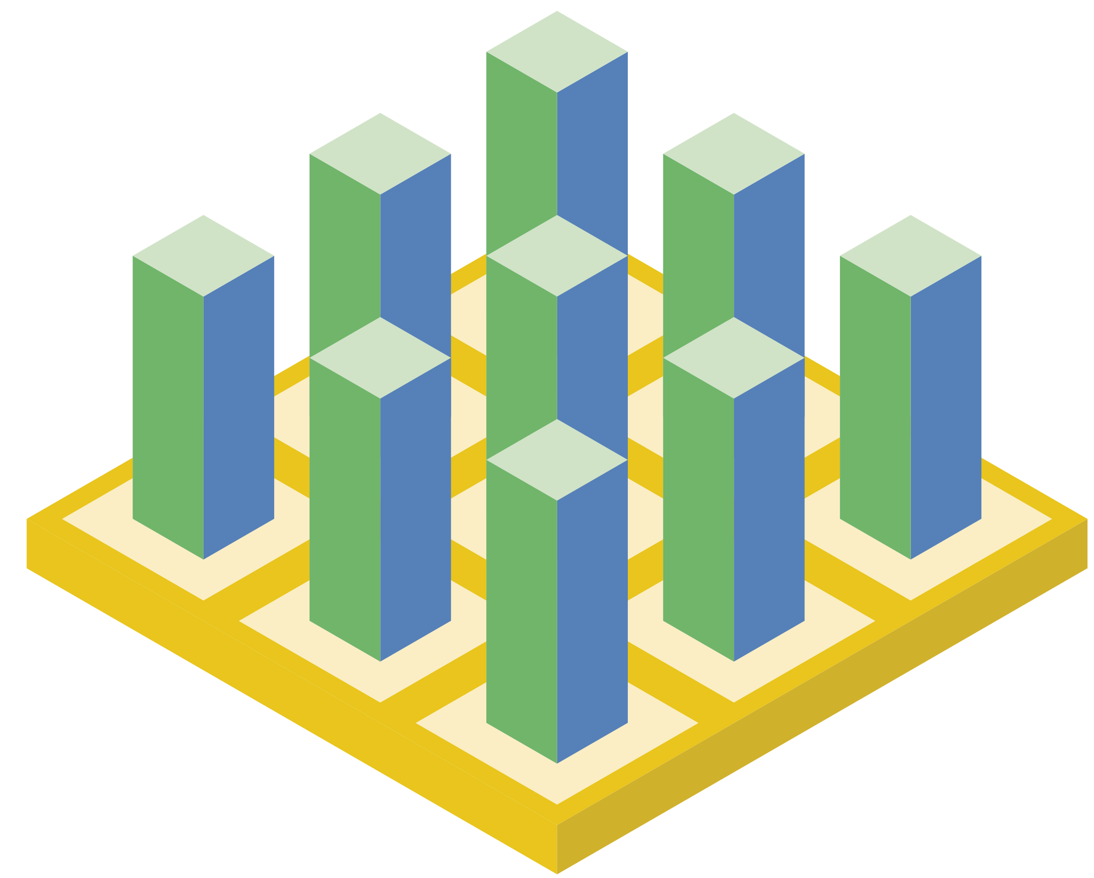
Cities also have a huge opportunity to affect meaningful change across scales by using the levers of policy, incentives, and planning to change the form of future buildings and environments. A first step could be requiring buildings to collect and report a greater level of real-time performance data, improving our ability to both quantify impact and identify real opportunities to improve performance at any stage in a building's life cycle.

At every scale, we must be at once pragmatic and visionary to achieve meaningful change. These analyses are a first step in those discussions, helping to identify "low hanging fruit"—strategies that are underutilized despite high ROI and impact, and should be implemented today—alongside those to watch in the future as ROI timelines shift faster along with technical and design innovation.

> "Community development projects that incorporate net-zero building requirements into their master plan can reap significant economic advantages when it comes to attracting tenants from high growth industries like the tech sector. These kinds of projects stand to gain from cheaper energy in the long run, and they are becoming more cost competitive in terms of upfront investment."

MICHAEL BENDEWALD
MANAGER, ROCKY MOUNTAIN INSTITUTE

Michael Bendewald is a manager at Rocky Mountain Institute, a globally recognized nonprofit that delivers business-led solutions for clean energy. He currently manages an initiative to deliver innovative financing mechanisms and business models for net-zero carbon districts in China and the US.



City/District

At the city/district scale, some of the most under-utilized strategies are those with significant impact but slower ROI. Policymakers, developers, and urban designers must develop a long-term perspective to sustainability, making decisions that will have significant effects over time.

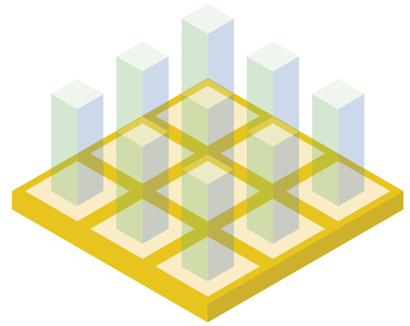
Buildings

At the building scale, some of the greatest opportunities for improvement are based on dramatic improvements in computing power and energy modeling in recent years. Sensors, real-time performance monitoring, and cloud computing can improve energy efficiently greatly.

Interiors

For interior environments, a key focus should be on generating better real-time data. But generating data is just the beginning—the real impact will come by using that data to both provide end-users with greater choice and control, and optimizing environments to improve efficiency without sacrificing that experience.

Opportunities at the City/District Scale



> "In terms of climate change, the next wave of innovation needs to come from improving the relationship between the building, the city, and our overarching energy infrastructure. Ecodistricts, microgrids, and waste energy recycling are the best long-term approaches to reducing our carbon footprint."

CHRISTOPH REINHART
PROFESSOR, DEPARTMENT OF ARCHITECTURE, MIT

Christoph Reinhart is a building scientist and expert in the field of sustainable building design and environmental modeling. He leads the Sustainable Design Lab at MIT, an inter-disciplinary group with a grounding in architecture, that develops design workflows, planning tools, and metrics to evaluate the environmental performance of buildings and neighborhoods.

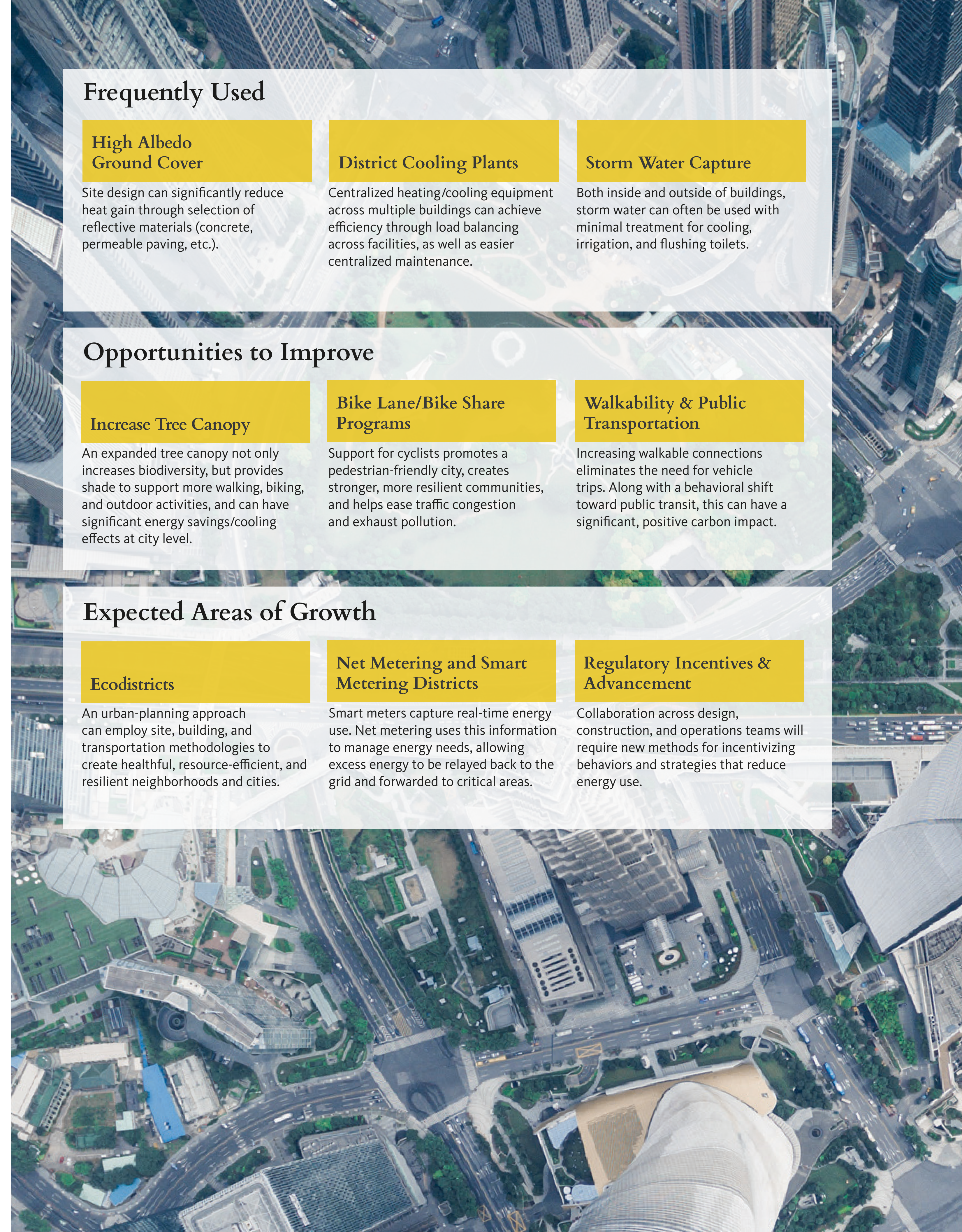
Cities account for just 2 percent of global landmass but contribute over 70 percent of global CO2 emissions. In many markets, the building sector is the single largest contributor to urban CO2 emissions, demonstrating significant opportunities for new sustainability solutions to make a big impact. But while the urban scale is potentially the most ripe for impact, the strategies identified often require the most collaboration to achieve.

From bike lanes to smart metering, these are, by definition, solutions that no single group or structure can achieve alone. They require not only greater cooperation, but also using levers like policy and community engagement to increase adoption of strategies with significant potential impact but a longer ROI timeline. Ecodistricts, expanded public transportation, microgrids and microturbines—these are just some strategies that communities and cities with vision can set the stage for today, to help ensure greater prosperity and resilience in the future.

Sustainable Strategies: City/District Scale

Definitions of all strategies are included in the appendix.

- *Anaerobic Digester Technology*
- *Bike Lanes/Bike Share Programs*
- *District Cooling Plants*
- *Ecodistricts*
- *Gray/Black Water Reclamation*
- *Green Roofs*
- *Heat Sink*
- *High Albedo Ground Cover*
- *Increase Tree Canopy*
- *Living Machine*
- *Microgrids*
- *Microturbines (Wind Power)*
- *Net Metering and Smart Metering Districts*
- *Walkability & Public Transportation*



Frequently Used

High Albedo Ground Cover

Site design can significantly reduce heat gain through selection of reflective materials (concrete, permeable paving, etc.).

District Cooling Plants

Centralized heating/cooling equipment across multiple buildings can achieve efficiency through load balancing across facilities, as well as easier centralized maintenance.

Storm Water Capture

Both inside and outside of buildings, storm water can often be used with minimal treatment for cooling, irrigation, and flushing toilets.

Opportunities to Improve

Increase Tree Canopy

An expanded tree canopy not only increases biodiversity, but provides shade to support more walking, biking, and outdoor activities, and can have significant energy savings/cooling effects at city level.

Bike Lane/Bike Share Programs

Support for cyclists promotes a pedestrian-friendly city, creates stronger, more resilient communities, and helps ease traffic congestion and exhaust pollution.

Walkability & Public Transportation

Increasing walkable connections eliminates the need for vehicle trips. Along with a behavioral shift toward public transit, this can have a significant, positive carbon impact.

Expected Areas of Growth

Ecodistricts

An urban-planning approach can employ site, building, and transportation methodologies to create healthful, resource-efficient, and resilient neighborhoods and cities.

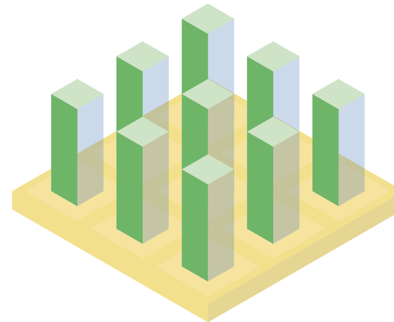
Net Metering and Smart Metering Districts

Smart meters capture real-time energy use. Net metering uses this information to manage energy needs, allowing excess energy to be relayed back to the grid and forwarded to critical areas.

Regulatory Incentives & Advancement

Collaboration across design, construction, and operations teams will require new methods for incentivizing behaviors and strategies that reduce energy use.

Opportunities at the Building Scale



> "As measurement verification from buildings becomes more common and cost-effective, it should be integrated into next-generation codes. Cost-effective sub-metering, in particular, can give facility managers real-time information to understand what sustainability strategies are working, and what needs improving."

BEN SHEPHERD
DIRECTOR, ATELIER TEN

The construction and operation of buildings accounts for over a third of global energy use. Improving their performance can make a huge difference as we work toward more ambitious energy efficiency and performance goals.

From a technology perspective, computational design has significant untapped potential to help explore new, more efficient building forms earlier in the design process. The Internet of Things is also poised to make huge gains in measuring, analyzing, and optimizing the real-time performance of our buildings.

But not all promising solutions are technology-based: operable windows could make a significant impact with wider utilization. And continuing to focus on reusing or renovating older buildings whenever possible should be the goal whenever possible—particularly in developed markets with significant amounts of old and under-utilized building stock.

Ben Shepherd is an expert in sustainability consulting, master planning, urban ecology, renewable energy systems, and green development assessments. In addition to his role at Atelier Ten, he teaches core courses on environmental design and building services for the Pratt Institute's Graduate Architecture and Urban Design program.

Sustainable Strategies: Building Scale

Definitions of all strategies are included in the appendix.

- *Active Louver Systems (Window Shading)*
- *Aerogel*
- *Air-to-Air Enthalpy Wheel*
- *Building Dashboard*
- *Building-integrated Photovoltaics*
- *Carbon Capture Cement*
- *Cloud Computing*
- *Computational Design*
- *Controlled Air Leakage*
- *Daylight Harvesting*
- *Demand Response*
- *Dynamic Façade*
- *Energy Modeling*
- *Energy Storage*
- *Fuel Cells*
- *Geothermal Energy*
- *Gray/Black Water Reclamation*
- *Green Roofs*
- *Ground Source Heat Pump*
- *Heat Sink*
- *Heat-recovery Chillers*
- *High Albedo Envelope*
- *High-performance Glass*
- *Light Tubes*
- *Light Emitting Diodes*
- *Operable Windows*
- *Peak Load Shedding*
- *Phase Change Materials*
- *Photovoltaics Panels*
- *Post-Occupancy Surveys*
- *Radiant Cooling/Heating*
- *Real-time Performance Modeling*
- *Reflective Foil Installation*
- *Site Planning/Orientation*
- *Skylight*
- *Solar Chimney/Stack Effect*
- *Solar Water Heating*
- *Static Louver Systems (Window Shading)*
- *Storm Water Capture*
- *Temperature Bridge/Thermal Isolation*
- *Thermal Mass*
- *Pre-Fabricated Curtain Wall Panels*
- *Wind Scoop*

Frequently Used

Air-to-Air Enthalpy Wheel

Also known as a thermal wheel or heat recovery wheel, these recovery technologies save energy by capturing exhausted air "enthalpy" to cool or heat incoming air.

High-Performance Glass

Window technologies can reduce heat gain and glare through the application of films, layers of glass, and vacuum air spaces in between.

High Albedo Envelope

Color and/or spectral finishes on building exteriors minimize thermal heat gain, helping the building's surface and interior stay cool, as well as the surrounding urban area.

Opportunities to Improve

Cloud Computing

Cloud computing supports new building management systems and smart appliances to reduce inefficiencies tied to building operations, and create responsive, adaptable systems.

Controlled Air Leakage

Single-pane glass and poor insulation continue to make air leakage a costly and energy-intensive problem for many large buildings due to leaks in building envelopes.

Real-Time Performance Modeling

Real-time performance modeling helps a team account for things such as thermal comfort, humidity, and daylight optimization, helping facility managers adopt operation strategies tied to current conditions.

Expected Areas of Growth

Energy Storage

New technologies are beginning to make battery storage smaller, more affordable, and safer—a necessity for the viability of renewables. Thermal or "cold" storage is also emerging as an alternative storage method.

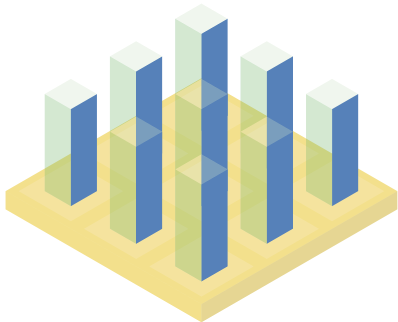
Radiant Cooling/Heating

The most effective way to provide thermal comfort for individuals is through heating or cooling surfaces that surround the inhabitant—for example, radiant floors and radiators.

Gray/Black Water Reclamation

Toilets, irrigation, and cooling systems can be supported by recaptured "gray water" from sinks or ground-plane water runoff with minimal treatment. "Black water" offers greater opportunity, but requires greater investment.

Opportunities at the Interior Scale



Improving the efficiency of heating, cooling, lighting, and electricity systems can help reduce the ongoing operation costs and impact of our interior environments. And given the amount of building energy use that is consumed by daily operations, the potential savings are huge. This is also the scale at which many companies have the most opportunity to act: interior environments can evolve and change at a much faster pace than buildings.

Based on our analysis, this is also the scale with the most untapped opportunity. There are a number of high ROI, high-impact strategies we could be employing in interior environments that currently aren't being leveraged to full effect. For example, better measuring of performance and space usage with post-occupancy surveys, real-time performance modeling, and right-sizing space utilization based on improved information. Another group involves increasing the amount of control individual occupants or end-users can have over their space by providing options such as ceiling fans, task lighting, or automated or "addressable" lighting.

Both of these strategies—better real-time data and greater user control—offer particular promise because they align with broader trends in the design and provision of our interior environments. From employees to hotel guests and retail shoppers, end-users are seeking greater choice and control in their interactions with the physical environment around them—and increased usage of sensors, along with traditional data-gathering techniques gives the opportunity to not only increase control, but also undersatnd the choices people are making. That information can be used by designers and building managers to optimize the physical environment to deliver a great experience along with great performance.

> "The answer for reducing energy consumption is not always more technology. Passive design can be just as effective. For example, central air often wastes a significant amount of energy and isn't optimal for all building users. In some cases, small design interventions like ceiling fans that are controlled in each individual workspace can be more effective and sustainable."

ALISDAIR McGREGOR
PhD, FELLOW + PRINCIPAL, ARUP

Alisdair McGregor is a leader in the field of sustainable design. He is a co-author of *Two Degrees: The Built Environment and Our Changing Climate*, and was named one of "The 100 Most Creative People in Business 2011" by *Fast Company* magazine.

Sustainable Strategies: Interior Scale

Definitions of all strategies are included in the appendix.

- *Addressable lighting*
- *Air-to-Air Enthalpy Wheel*
- *Ceiling Fans*
- *Cloud Computing*
- *Controlled Receptacle (Plug Load Control)*
- *Demand Dimming*
- *Dynamic Load Mapping*
- *ENERGY STAR*
- *Food Waste Composting*
- *Light Emitting Diodes*
- *Operable Windows*
- *Plug Load and Lighting Budgets*
- *Post-Occupancy Surveys*
- *Right-size Space Utilization*
- *Skylight*
- *Task Lighting*

Frequently Used

Lighting Innovations

Advances such as LED (light emitting diode) technology, task lighting, and demand dimming are helping reduce both lighting requirements and energy usage.

Right-Size Space Utilization

Not only does excess space per person require more capital outlay, but that volume of space needs to be cooled/heated and lit during the working hours—space efficiencies also deliver energy efficiencies.

ENERGY STAR Appliances

ENERGY STAR is an EPA rating system for comparing the energy efficiency of most electricity-using lighting and appliances.

Opportunities to Improve

Daylight Harvesting

The design of a building's floor plate dimensions, façade details, orientation, and glazing types to maximize the amount of daylight in a space. Ideally only nighttime usage or emergency situations will require man-made lighting.

Ceiling Fans

Ceiling fans may be an older technology, but they work to enhance thermal comfort even in higher temperatures. They are adjustable on an individual basis.

Plug Load and Lighting Budgets

For a better understanding of demand and right-sizing of building systems, design teams establish both light and plug load targets per area of space to optimize operational parameters.

Expected Areas of Growth

Dynamic Load Mapping

Applying computational analytics to understand, predict, and minimize energy demand, and develop preemptive systems approaches to manage demand in the future.

Continuous Improvement Partnerships

A continued partnership with the client post move-in to identify material resource strategies and pursue goals of ongoing energy use reduction and performance optimization.

Demand Response

Sensor technology or predictive models modify power usage to support the actual occupancy demand in the workplace.

Conclusion

Where We Go From Here

After extensive analysis of the predicted energy performance for all of Gensler's projects in 2016, a few things have become clear. First, the collaborative relationship between Gensler and our clients has led to significant improvements in our projects' energy performance in a very short time. In a report published last year following the completion of the UN's Paris Agreement and Gensler's decision to sign the Paris Pledge for Action, we estimated that our 2014 projects save a projected 4 million metric tons of CO2 emissions every year through gains in energy efficiency. This year, we project that Gensler's 2016 projects should save 11 million metric tons of CO2 each year through even more substantial gains in energy efficiency across Gensler's broader portfolio.

We are continuously refining our process for collecting energy performance data for our portfolio and predicting our total impact, and this accounts for some of the variance between each of our published reports. Some of the most significant drivers of this improvement are stronger building codes in commercial real estate markets around the world, greater market share for maturing technologies (such as LED lighting), and an expanding green materials market that has made it easier for Gensler to meet our clients' increasing commitments to a better, more sustainable future.

At the same time, our research indicates that the AEC industry may be reaching an inflection point where significant future emissions reductions may not be possible through energy efficiency measures alone. For Gensler to reach our long-term goal of having every project we work on eventually be carbon neutral or energy positive, renewable energy sources will need to become more common in commercial real estate markets around the world. Innovative technologies such as microgrids, ecodistricts, and heat-recovery chillers are paving the way for a carbon-neutral future, and the increasing cost competitiveness of solar and wind energy leaves significant room for optimism.

Our Commitment

We commit to using the power of design to make a positive impact through every project we design and deliver. This is true whether we are working with our clients and communities to create a new neighborhood, design a new building, or upgrade an existing space or structure. Our approach to impactful design supports a future environment that is more resilient, less dependent on fossil fuels, and ultimately more healthful and productive for future generations.

Achieving a more resilient future for our cities and communities will be challenging work, but we believe the future is bright. Getting there will require new levels of collaboration and coordination between the following:

Diverse disciplines, experts working together to inspire new thinking and add depth to human-centered and life cycle-focused design thinking.

Public and private entities, governments, not-for-profits, businesses, and communities to garner public support and align goals and resources.

Project scales and geographies, ranging from big moves and investments at urban and neighborhood levels to small interventions that improve the performance of environments in stores, homes, and workplaces.

As we seek broader partnerships, the conversation will continue to inspire and expand beyond energy performance to encompass a broader range of sustainable goals and metrics. Ultimately, we seek to leverage every project at Gensler as an opportunity to enhance the human experience, improve the performance of our organizations and communities, and reduce our collective impact on the planet.

AltaSea at the Port of Los Angeles represents the next generation of civic facilities that will strive for net-positive outcomes. Built on an historic pier with access to the deep ocean, AltaSea's 35-acre campus will bring people together to expand science-based understanding of the ocean; incubate and sustain ocean-related business; and pioneer new ocean-related education programs.

ACTION STEPS

In our first report documenting the sustainable performance and impact of our projects, we identified a series of next steps to formalize our Climate Action commitment. As we look ahead, we propose the following action items to lay the groundwork for future success:

Establish sustainability goals at project kickoff.

Initiate energy and other resource stewardship conversations on all projects at the onset of the design process, documenting energy targets and sustainable goals early. To inform those conversations, employ energy models and simulations on every project possible, leveraging advances in computational design to simulate and consider a broader range of design scenarios.

Expand the performance metrics collected on all projects.

Quantifying our impact is the first step to reducing it; as designers we must commit to measuring a wider range of performance factors on every project. For example, prior to specifying materials, create a more holistic picture of impact by understanding the material's life cycle and embodied energy.

Include building operators in the design process.

Cooperation grows understanding and awareness of energy goals and better enables design teams to equip building operators with practical tools they can put to use. The goal is to design building operating systems that people know how to use effectively, and then build on that knowledge through post-occupancy evaluations on all projects. This enables collaborative design and operations teams to understand how spaces are actually working and to fine-tune and calibrate projects on an ongoing basis.

Appendix

Reed Smith's Philadelphia offices are designed to perform 34 percent better than a standard code-compliant design.

"Next generation materials like low carbon concrete and cross-laminated timber will eventually be able to replace more carbon-intensive structural materials for large commercial projects. Continued innovation will help the building industry further reduce its environmental footprint."

DIRK KESTNER,
PRINCIPAL + DIRECTOR OF SUSTAINABLE DESIGN,
WALTER P MOORE

Dirk Kestner is the Corporate Director of Sustainable Design and a Principal for Walter P. Moore, a member of the LEED Materials and Resources Technical Advisory Group (MR TAG), and was editor for the Structural Engineering Institute's publication *Sustainability Guideline for the Structural Engineer*.

Community Impact

#1

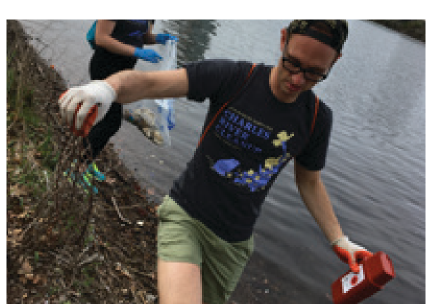
Top Green Building Design Firm

Gensler was ranked as the #1 Green Buildings Design Firm by Engineering News Record, with both the highest revenue from green design and the most green accredited staff.

Gensler Offices Honor Earth Day with River Cleanup Efforts

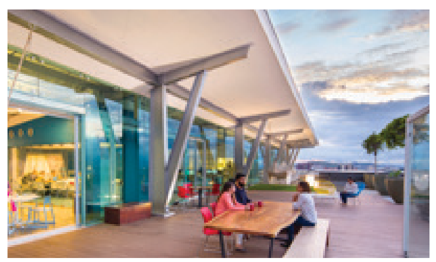
Gensler DC participated in the Anacostia Watershed Society's Earth Day cleanup, which helped to remove 14,690 pounds of garbage and 9,220 pounds of recyclable materials from area parks and waterways.

Gensler Boston participated in a cleanup organized by the Charles River Conservancy, helping to make the city's river a cleaner and healthier waterway, while also preparing adjacent parklands for recreational use.



Diane Hoskins Speaks at International Women's Forum 2017 World Cornerstone Conference

Gensler Co-CEO Diane Hoskins joined a panel at the International Women's Forum's 2017 World Cornerstone Conference in Stockholm, Sweden, to discuss urbanization and climate change. Photo courtesy of Jonas Borg Photography.



Gensler Costa Rica Invests in Composting and Organic Gardening

Gensler Costa Rica features an organic garden where 25kg of food waste is composted and converted into organic fertilizer each week.

Gensler Raises Money for Hurricane Recovery Efforts

Gensler Houston organized a firmwide donation drive, raising over $80,000 from Gensler staff to support rebuilding efforts in Houston. These funds were matched by the firm.

"Mi Jardin" Seed Bomb Workshop

The AIA Design Voice Committee in Austin, Texas, partnered with Capital Metro, one of the most important transportation hubs in Austin with more than 200 boardings per day, to host a design charrette to design a bus stop shelter composed of two bus stops. Teams were encouraged to submit designs that expressed the community, and show Seed Network principles. The teams had four weeks to develop designs and submit their presentations. The winning design's vision: to create a transit-oriented pedestrian plaza that would be an oasis, a community garden, "Mi Jardin." The bus shelters harvest rainwater to irrigate the garden, with a colorful design tied to the community.

Gensler at SXSW Eco 2016: Transforming Public Space

Two Gensler projects reinventing the way we experience public space were recognized as South by Southwest (SXSW) Eco 2016 Place by Design finalists: The Loop and the Town Square Initiative/Pershing Square Renew in Los Angeles. The Loop, a 7,700-square-foot interactive playground framed by a colorful 500-foot-long, 25-foot-high space truss, is a next-generation urban activation platform in Long Beach, California. Part of the Town Square Initiative, Gensler's global prompt to study the future role of open space in a rapidly urbanizing world, Pershing Square renews a space in flux and reimagines it as a vibrant community asset.

Andy Cohen Speaks at Stanford on Autonomous Vehicles and Sustainable Urban Infrastructure

Gensler Co-CEO Andy Cohen is frequently quoted as an expert on the impact of autonomous vehicles on real estate, and a leading voice in how to design buildings today to accommodate a shift toward autonomous vehicles in the future.

Gensler Offices Achieve LEED Certification

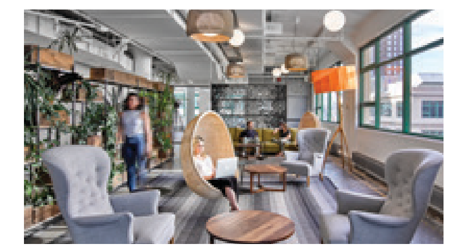
We continue to express our commitment to sustainability through the design of our own offices worldwide. Multiple Gensler offices recently received or are pursuing LEED certification, including Gensler Costa Rica (LEED CI V3 Platinum), Gensler Denver (LEED IC+C V4 Certified), and Gensler New York (LEED ID+C V4 Registered).

Shanghai Tower Double-Skin Facade Recognized as One of "100 Greatest Innovations of 2016"

Popsci.com included Gensler's design for a double-skin façade for Shanghai Tower as one of the greatest innovations of the year, recognizing its façade innovation and status as an "extra-green" skyscraper.

Boston Green Academy Gets a Sustainable Library Uprade

Gensler and Turner Construction teamed up with City Year and the Boston Green Academy to redesign and update the school's multipurpose library space. With sustainability at the heart of the school's mission, the team used green building materials, reused existing bookshelves, and added flexible new furniture that can grow with the school.



Etsy Headquarters Honored by Center for Active Design

Etsy's new Brooklyn, NY, headquarters was given an "Excellence" Award by the Center for Active Design, recognizing its adherence to active design principles, incorporation of nature, and connection to the community.

THE CITIES OF THE FUTURE WILL BE DEFINED BY WATER

Rives Taylor quoted in *Fast Company* about "passively smart" cities

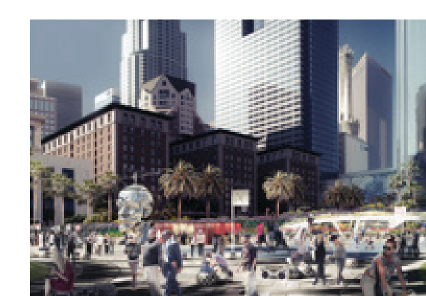
Rives Taylor, a Gensler Design Resilience leader and sustainability expert, underscores the importance of low-impact development, passive design, and creating "permeable" development.

Hess Tower Wins BOMA Award for Operational and Sustainable Excellence

The Gensler-designed Hess Tower in downtown Houston received a 2017 TOBY (The Outstanding Building of the Year) Award, recognizing sustainable impact and operational excellence. The building was also the first LEED Core & Shell Platinum certified building in Houston's CBD.

Toward the First Net-Zero Automotive Dealership

Gensler has partnered with Toyota to design net-zero automobile dealerships across North America. Toyota Corvallis, above, is on track to become the world's first certified net-zero energy automotive dealership.



Sustainable Strategies at Every Scale

Active Louver Systems (Window Shading)
An approach to building cooling and lighting, active louver systems rely on sensors to proactively shade different areas of a floorplan based on the position of the sun and season of the year, adjusting to maximize comfort and minimize the amount of energy needed to maintain a consistent climate within a building.

Addressable Lighting
Individually controlled ambient lighting, addressable lighting is provided via occupancy sensors or personal control of lighting levels.

Aerogel
Aerogel is a synthetic, porous, and lightweight material that provides an additional layer of wall panel and roof insulation that reduces thermal heat gain and limits external energy loss by keeping climate-controlled air inside the building.

Air-to-Air Enthalpy Wheel
Sometimes referred to as a thermal wheel, an air-to-air enthalpy wheel recovers heat energy from the supply and exhaust streams of air-handling systems.

Anaerobic Digester Technology
Anaerobic digestion occurs when microorganisms break down biodegradable material in the absence of oxygen. The process produces biogas that can be used to produce electricity, or other fuels. As a technology that converts waste to energy, this waste management strategy can lower capital costs.

Bike Lanes/Bike Share Programs
Bike lanes allow for a more pedestrian-friendly neighborhood or city, creating stronger, healthier and more resilient communities. Installation of lanes and sharing programs encourages bike usage, cutting down on traffic congestion and pollution from personal vehicles.

Building Dashboard
We can only improve what we can measure. Building dashboards provide a real time and digitally graphic means for measuring a building's energy consumption. These tools can compare past performance with current energy utilization, analyzing occupant behavior to help building managers and users to understand the difference.

Building-integrated Photovoltaics
The next phase of solar photovoltaic technology embeds silicates directly into external materials, such as window glass, walls, and roofs, to generate solar energy from a wider surface area than traditional solar panels.

Carbon Capture Cement
After water, Portland cement is the second most consumed material on the planet and is responsible for five percent of global greenhouse gas emissions. Carbon capture cement is a promising technology currently in the experimental phases that would be stronger and lighter than Portland cement, and holds enormous potential as a sustainable building material of the future. The added benefit of capturing and sequestering carbon means that buildings can play an even larger role in the fight against climate change.

Ceiling Fans
Ceiling fans may be an older technology, but they work to enhance thermal comfort even in higher temperatures, and they are adjustable on an individual basis.

Cloud Computing
Cloud computing can reduce the energy load of a building by removing the need to maintain extensive IT infrastructure on site. It also has the capacity to support new building management systems and smart appliances, which can reduce inefficiencies tied to managing and operating a building.

Computational Design
Computational design is not a new technology, but it holds enormous potential for building sustainability. This is an analytic process that enhances integrated architectural and engineering design by allowing teams to identify quantitative means of improving building performance and energy efficiency at the beginning of a project.

Controlled Air Leakage
Buildings waste a significant amount of energy due to natural laws of thermodynamics (heat seeks cold). In the summer, warm air from outside seeks to enter a climate-controlled area, forcing a building's HVAC system to work harder to keep a building comfortable. The inverse is true in the winter. Single-pane glass and poor insulation make air leakage a costly and energy-intensive problem for large buildings.

Controlled Receptacle (Plug Load Control)
Individually controlled appliance plugs (often connected to occupancy sensors)-minimize standby power use (electric power consumed by appliances that are switched off, or are in standby mode).

Daylight Harvesting
Daylight harvesting is a strategy that reduces excessive lighting use by using ambient light (natural or artificial). The design of the building's floorplate dimensions, façade details, orientation and glazing types work together to effectively create a daylit experience, with only nighttime usage or emergency situations requiring man-made lighting.

Demand Dimming
As part of ambient or task lighting controls, demand dimming is a method to align energy use with occupancy needs, or as a larger daylight harvesting strategy.

Demand Response
De-centralized demand response systems operate at a level beyond "demand dimming" occupancy sensors, using algorithms to learn use patterns and creating recommendations for optimizing use. Predictive models can modify power use to support the actual occupancy demand in the workplace.

District Cooling Plants
District cooling plants centralize heating/cooling equipment across multiple buildings to achieve efficiency by balancing loads across buildings and easing required maintenance. Whether used in a central city downtown or on a campus, central plant engineering right-sizing and optimization will support human comfort at an economical price point. These systems can be tied to real time and regional energy generation and distribution factors.

Dynamic Façade
This technology optimizes solar shading based on seasonal shifts in climate, aligning its response to shading with the solar calendar or a building's orientation to the sun at various times in the calendar year. Each façade operates independently and responds on its own to solar heat gain and glare, meaning that dynamic facades require extensive motorization, as well as a sophisticated real-time and predictive sensor array.

Dynamic Load Mapping
Key in both design and operations is mapping the source of energy demands from unexplained appliance electricity usage or occupant thermal discomfort. Dynamic load mapping helps us understand sources of energy demand and provides a means to satisfy or minimize that demand through building orientation, glazing percentage or another technology application.

Ecodistricts
An urban planning approach that employs site, building, and transportation methodologies to create a more healthful and resource-efficient neighborhood. Increasingly, these districts also focus on resilience strategies to withstand climate, social, and resource shocks. Microgrids are often integrated into these ecodistricts (see later definition of "microgrids").

Energy Modeling
Energy modeling is one possible output of computational design. This approach to building efficiency simulates a project's full energy use, including lighting, water pumping and mechanical systems, directing the building design process toward more passive strategies and optimal mechanical systems.

ENERGY STAR
ENERGY STAR is an EPA rating that provides consumer clarity regarding the energy efficiency of most electricity-using lighting and appliances that often run 24 hours a day.

Energy Storage
Energy storage has historically been the single greatest challenge for renewable energy. To make renewables a reliable and cost-effective alternative to more carbon-intensive energy sources, it is critical that the energy produced during peak sun or wind hours can be stored for future use. Developing technologies are making battery storage smaller, more affordable, and safer to use. Microgrids and buildings that are fully self-sufficient are the primary beneficiaries of energy storage. (See also definitions of "microgrid" and "fuel cells").

Food Waste Composting
Either at home or in the office, composting food waste rather than transporting it to landfills can be beneficial for local biodiversity and help to cut down on a significant source of methane gas.

Fuel Cells
This non-combustion power resource, fueled by natural gas or hydrogen, employs an electrolytic process that strips electrons from the natural gas to create electricity. Fuel cells are not fully carbon neutral, but they have zero carbon emissions, making them a clean and predictable power source.

Geothermal Energy
See "Ground Source Heat Pump"

Gray/Black Water Reclamation
Gray water reclamation is the process of collecting condensate or other water for reuse within a building system with minimal human waste issues. This water can be reused to employ excess shower or sink drainage for irrigation or non-human uses, for example. Black water reclamation contains human waste and requires a complex cleansing process necessitating onsite water treatment. Both methods have potential energy-saving opportunities by reducing demand for centralized water purification and distribution across a city—one of the largest power demands in a city's portfolio.

Green Roofs
The best way to minimize heat gain in most buildings is by making improvements to the roof. Green roofs add a layer of biodiversity between a building and the sun, creating a highly effective insulation from heat and improving a roof's longevity. Green roofs also help retain rainwater and minimize the negative impacts of regular storm water. (See also, "Storm Water Capture")

Ground Source Heat Pump
This methodology relies upon the stability of the ground or large bodies of water to provide temperature control that feeds into a building's mechanical systems. This helps to mediate temperature and humidity swings in the building's inhabited space.

Heat Sink
Using the physics of enthalpy or thermal mass absorption, this passive design strategy uses mass to absorb heat for warmth. This re-radiation of thermal energy can be used for human comfort in challenging environments.

Heat-recovery Chillers
Often employed in conjunction with cogeneration or large heat sources like data centers or concentrated office building exhaust plenums, heat-recovery chillers capture waste heat and turn it into chilled water to cool the entire building.

High Albedo Envelope
The sun is a great source of power. Through the selective use of color and spectral finish on building exteriors, thermal heat gain can be minimized. Not only does the building surface and interior remain cool, but the surrounding urban environment does, too.

High Albedo Ground Cover
In addition to cool roofs, site design can deliver heat gain reduction (reducing urban heat island effect) through selection of surfaces—which may also enhance storm water retention. Methods include light-colored concrete or permeable paving.

High-performance Glass
High-performance glass reduces heat gain and glare through the application of films and/or layers of glass with vacuum air spaces in between. There are a variety of window product coefficients that connotate this performance, for example visible light transmittance, heat gain, insulation and ultraviolet blocking capacity.

Increase Tree Canopy
Tree canopy refers to the layer of branches, stems and leaves that cover ground area. Using trees to provide shade from the sun is a very old and very effective passive design strategy to mitigate the hot summer sun and cold blasts from winter winds. In addition to biodiversity and resilience advantages, an urban strategy that prioritizes increased tree canopy can precipitate more walking and biking, while creating cooler urban areas.

Light Tubes
Light tubes are a wide fiber optic technology that transmits daylight throughout a building by harnessing sunlight from the building's perimeter or skylights and releasing it across the range of occupied spaces.

Light Emitting Diodes
Light emitting diode (LED) technology allows for better energy efficiency, provides better ambient and task lighting, and its quality is far closer to natural daylight than traditional light bulbs. LEDs do not eliminate heat from their ballast, meaning they continue to generate heat waste, but their overall impact on large commercial interiors is overwhelmingly positive.

Living Machine
A proprietary technology that harvests a facility's gray and black liquid waste and creates clean water by employing natural micro and macro organisms and plants in the process.

Microgrids
Microgrids are independent power grids serving a small district, neighborhood or campus. They often use renewable resources such as solar or wind power to create a completely independent energy system on a small scale. Microgrids are more resilient than traditional single-utility model grids, and they offer rapidly urbanizing areas a lower cost alternative to build electrical power as an area grows, decreasing the amount of upfront social investment needed to provide steady, reliable power.

Microturbines (Wind Power)
Microturbines can provide renewable and resilient power generation when integrated with buildings. While freestanding microturbines are widely used, integrating this technology with buildings can be costly and adoption is slow.

Temperature Bridge/Thermal Isolation
Modern buildings rely on mechanical fasteners to connect a building's external shell to its internal structure. This is called a temperature bridge. Typically, these fasteners are considered part of the building's insulation, but their material composition creates a thermal link between the building's outside and inside, rendering the building's insulation less effective in the process. The advent of new materials has mediated this problem and has a significant impact on overall building efficiency by decreasing the amount of energy needed to heat or cool a building.

Net Metering and Smart Metering Districts
Net metering forwards energy to the most critical needs, and allows for partnerships with the energy grid to reduce nonessential needs in peak loads. This strategy is applicable at building and district scales.

Operable Windows
Windows remain one of the best passive design strategies available today. Natural ventilation can offset the need for a centralized climate control system, while also providing access to fresh air and the natural environment.

Peak Load Shedding
Employing thermal storage, onsite electrical generation, or alternative energy storage arrangements, this operational strategy offsets the demand a building places on the external grid during times of peak energy demand (generally during weekday working hours). While many of these tactics do not reduce total energy demand, solar power is a good example of an energy-reducing peak load shaving opportunity.

Phase Change Materials
Phase change materials hold tremendous promise as a potential building material of the future. These materials have a chemistry that allows for both insulation and cooling by responding to humidity and thermal conditions. This approach negates air leakage by allowing air to escape to improve indoor conditions. The inverse can be employed, too.

Photovoltaics Panels
At over 60 years old, photovoltaics or "solar panels" are a mature technology. Limiting factors continue to be access to sunlight and the weather, but solar technology continues to improve every year and the current generation of photovoltaics is far more efficient at capturing sunlight and converting it into electricity.

Plug Load and Lighting Budgets
For a better understanding of demand and right-sizing of building systems, design teams establish both light and plug load targets per area of space to optimize operational parameters.

Post-Occupancy Surveys
Post-occupancy surveys are a common tool used by architects and designers to evaluate the success of a building or interiors project. They can promote energy optimization by aligning human factors with the design process, providing design teams additional insights in terms of what worked or could be improved in the next design effort.

Radiant Cooling/Heating
The most effective way to provide thermal comfort for individuals is through heating or cooling surfaces that surround the inhabitant, e.g., radiant floors and radiators. At the building scale, moving liquid refrigerant from a central facility plant to localized "radiators" is far more effective than moving massive amounts of thermally treated air.

Real-time Performance Modeling
Performance modeling in real time can help to identify design strategies for long-term building performance. Real-time performance modeling helps teams account for things such as thermal comfort, humidity and daylight optimization, helping facilities managers adopt operations strategies tied to current conditions.

Reflective Foil Installation
Solar heat gain is both uncomfortable and destructive to our buildings. Reflective foil installation uses super-thin materials, intra-wall solar barriers, or surface materials in fenestration, to reduce the heat gain of our individual built environment. However, this energy is reflected elsewhere with sometimes problematic outcomes.

Right-size Space Utilization
Not only does excess space per person require more capital outlay, but that volume of space needs to be cooled/heated and lit during the working hours. "Rightsizing" both how much space per person and the power necessary to run a space is a vital first step in design. Finding the right balance is essential, however—overly dense environments can have a negative impact on employee performance and well-being.

Site Planning/Orientation
Properly orienting a building is a passive design strategy that requires little upfront investment, but generates significant long-term benefits in terms of shading, daylight optimization, and lessening heating and cooling needs by protecting a building from forces like wind.

Skylight
These allow daylight to enter areas of a floorplan that are otherwise separated from a window, saving energy by leveraging natural instead of artificial lighting sources.

Solar Chimney/Stack Effect
Augmenting the law of thermodynamics (as air heats, it rises), solar chimneys are designed stacks that organize a building to induce cool air induction and hot air exhaust to offset internal heat gains. Functioning similarly to a clothes dryer exhaust system, solar chimneys allow hot air to escape. Air flow can be accelerated by dark surfaces or solar "hot pads" at the top of the facility exhaust.

Solar Water Heating
An ancient technology using the sun to heat water, either through roof collector panels, concentrator technology, or bladder systems.

Static Louver Systems (Window Shading)
Employing traditional solar altitude and azimuth analysis techniques, this design approach recognizes the different orientations from which the building receives different solar heat gains. This passive design approach employs fixed shading devices of appropriate scale and orientation to provide optimal shading or indirect lighting most of the year.

Storm Water Capture
Buildings can use sophisticated draining systems to capture and re-use rain water. Often not requiring treatment, rainwater can be used both inside and outside of buildings for cooling, irrigation, and flushing toilets.

Task Lighting
Providing task lighting to users allows organizations to offset an overabundance of ceiling-based ambient lighting by placing lighting closer to work surfaces that are more controllable by users.

Temperature Bridge/Thermal Isolation
Modern buildings rely on mechanical fasteners to connect a building's external shell to its internal structure. This is called a temperature bridge. Typically, these fasteners are considered part of the building's insulation, but their material composition creates a thermal link between the building's outside and inside, rendering the building's insulation less effective in the process. The advent of new materials has mediated this problem and has a significant impact on overall building efficiency by decreasing the amount of energy needed to heat or cool a building.

Thermal Mass
At a building level, a thermal mass strategy leverages daytime and nighttime temperature swings through absorptive and heavy materials that capture and retain desired temperatures.

Pre-Fabricated Curtain Wall Panels
These are pre-fabricated structural panels with appropriate insulation and vapor barrier technologies that foster construction optimization and operational performance.

Walkability & Public Transportation
Public transportation reduces the need for parking and concrete roadways, allowing individuals to use alternative transportation strategies that limit the need for personal vehicles. Public transportation has a very large, and very positive carbon impact, when it is designed well and integrated properly into a community.

Wind Scoop
Wind scoops are roof penetrations that often have a dual purpose of providing daylight and ventilation. They are often established through a gimbal approach, which redirects the wind scoop according to wind direction.

Methodology

Glossary of Terms

- **EUI (Energy Use Intensity):** a measure of annual building energy use, expressed in kBtu/sf/yr.
- **PEUI (Predicted Energy Use Intensity):** a measure of predicted building energy use, expressed in kBtu/sf/yr.
- **CBECS (Commercial Buildings Energy Consumption Survey):** a national survey of various types, sizes, and occupancies of buildings in all regions of the US. This data is then normalized and cleaned to give an accurate estimate of commercial building energy use in the US. This is a measure of actual energy use and includes regulated (building system) loads and non-regulated (computers, coffee makers, portable equipment) loads.
- **National Baseline EUI:** a constructed EUI for a particular project type and occupancy based on the CBECS data.
- **LPD (Lighting Power Density):** a measure of the installed Watts due to lighting systems in a building, expressed in Watts/sf.
- **ASHRAE 90.1 2007 (Energy Standard for Buildings Except Low-Rise Residential Buildings):** is an international standard that provides minimum requirements for energy efficient designs for buildings except for low-rise residential buildings.
- **PLPD (Predicted Lighting Power Density):** a measure of predicted building energy use, expressed in kBtu/sf/yr.
- **PS:** project size in square feet.

Data imputation and cleaning methodology for buildings (EUI) and interiors (LPD)

Data points for both buildings (EUI) and interiors (LPD) projects were imputed in case of missing/inaccurate national baseline (CBECS 2003 for EUI, ASHRAE National Baseline 90.1 2007 for LPD), local code baseline and PEUI and PLPD.

Portfolio size calculation methodology:

61% of Gensler's 2016 portfolio included reported square footage data. Therefore, 39% of the portfolio was estimated based on project type and adjusted to derive a conservative estimate.

- An average square footage of each project category was calculated based on available square feet data.
- The obtained project category average square feet was imputed in case of missing data.
- Total square footage of the reported projects (61%) was calculated.
- A sum of all estimated square footage portfolio (39%) was calculated.
- The estimated portfolio size (39%) was reduced by 25% to adjust for variations in the data and to obtain a conservative estimate of the estimated portfolio size.
- Both the reported and estimated square feet totals were added to obtain the total portfolio size.

Baseline EUI/LPD methodology:

Appropriate adjustments were made to CBECS national baseline, ASHARE 90.1 2007, local code baseline and predicted project performance in case of missing/inaccurate values using domain knowledge and details.

- In the case of EUI a separate National Baseline EUI was created to reflect these adjustments, which was used in all subsequent analysis.
- National baseline EUI was estimated according to project type and location and domain knowledge. If data was unavailable for projects such as, mixed use and data centers it was estimated by using difference from local code (20%-40% higher depending on jurisdiction).
- Local code baseline was estimated to be 20%-40% lower than CBECS code based on project jurisdiction.
- Predicted project performance (PEUI for new buildings and PLPD for buildings interiors projects) was assumed to be at least equal to local code as this is mandated by law. Since all our projects must meet or exceed local code requirements local code information was used as proxy for predicted project performance.

Note: No adjustments were made to buildings interiors data.

Portfolio performance analysis methodology

Analysis was conducted only on projects that had reported estimates of predicted performance for new buildings (PEUI) and buildings interiors (PLPD). Therefore, the data for projects with reported PEUI and PLPD was separated from all other data for all subsequent analysis.

Data clean up

- The projects with PEUI and PLPD were separated from other projects.
- Projects with a National Baseline EUI of over 1000 kBtu/sf/yr were excluded from analysis on new buildings.

Data Analysis

National Baseline (CBECS for new buildings, ASHRAE 90.1 2007 for buildings interiors), local code baseline (for both new buildings and building interiors) and the PEUI and PLPD were multiplied by the PS in square feet. Estimated PS was used in case of missing data.

Average portfolio performance

Average national baseline on new buildings and buildings interiors were calculated for the whole portfolio using the following formulae:

- (∑(National Baseline EUI * PS))/PS.
- (∑(ASHRAE National Baseline 90.1 2007 * PS))/ ∑PS.

Average predicted portfolio performance on new buildings and buildings interiors were calculated for the whole portfolio using the following formulae:

- (∑(PEUI * PS))/ ∑PS.
- (∑(PLPD * PS))/ ∑PS.

Portfolio performance percentage improvement over national baseline

Average portfolio percentage improvement over national baseline was calculated using the following formula for new buildings and buildings interiors.

- New buildings: (¯X(National Baseline EUI*PS))-(¯X(PEUI*PS))
- Buildings Interiors: (¯(X)(ASHRAE 90.1 2007*PS))- (¯X(PLPD*PS))

Methodology for energy saved and carbon emission reduction projections: EUI

New Buildings Analysis (EUI)

Metrics used in the analysis of energy saved and carbon reduction for new buildings:

- New buildings portfolio size in square feet for 2016
- The average National Baseline EUI for 2016
- The average PEUI building performance for 2016

Calculation of energy saved and conversion of EUI to kilowatt-hours:

The metrics were converted to energy saved in kilowatt-hours per year using the following formula by project type:

- New buildings: (¯X(National Baseline EUI*PS))-(¯X(PEUI*PS)

Note: 1 kBtu = .29307 kWh.

The metrics were converted to energy saved in kilowatt-hours per year using the following formula by project type:

- ((∑((PS x National Baseline EUI) – (PS x P EUI))) x 0.293)*13.

Note: 13 is derived from 2030-2017=13.

All equivalencies were calculated through entering energy reduction stats into the US EPA Greenhouse Gas Equivalencies Calculator *(https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator)*

Methodology for energy saved and carbon emission reduction projection: LPD

Metrics used in the analysis of energy saved and carbon reduction for buildings interiors:

- Buildings interiors portfolio size in square feet for 2016
- The ASHRAE 90.1 2007 National Baseline LPD for 2016
- The predicted LPD, building performance for 2016

Carbon emission reduction calculation process:

Calculation of energy saved and conversion of LPD, to kilowatt-hours: The metrics were converted to energy saved in kilowatt-hours per year: using the following formula:

- (∑((PS x ASHRAE 90.1-2007 National Baseline LPD) – (PS x PLPD)))/1000

Energy savings were then projected till 2030 using the following formula: (∑(((PS x ASHRAE 90.1-2007 National Baseline LPD) – (PS x predicted LPD))/1000)) *3120 hours.

*Note: 3120 hours refers to time during which lighting is likely to be needed in a building over 52 weeks/ year (60*52=3210).*

Actual energy consumption of the building was calculated by the following formula (PS*PLPD*3120) employing the same unit conversion to kilowatt-hours.

Methodology for landfill diversion CO2 equivalencies

Carbon reductions from landfill diversion were calculated using the US EPA's Waste Reduction Model (WARM), which has been designed to help solid waste planners and organizations estimate greenhouse gas (GHG) emissions reductions from different waste management practices.

WARM calculates GHG emissions for baseline and alternative waste management practices, including source reduction, recycling, combustion, composting, and landfilling. The model calculates emissions in metric tons of carbon dioxide equivalent (MTCO2E) and metric tons of carbon equivalent (MTCE) across a wide range of material types commonly found in municipal solid waste (MSW). The excel version of WARM was used to calculate the carbon reduction for each project.

For projects that a specific material breakdown was available, those metrics were input directly into the WARM model. For projects where only a total weight in raw tonnage of diverted materials had been documented by the site management team, or in cases where only a partial material breakdown was available, the total weight of diverted waste was broken down according to a matrix devised through the help of expert consultation. The majority of all construction waste is predicted to fall into one of the of following nine categories (corrugate containers, concrete, drywall, mixed metals, mixed plastics, carpet, fiberglass insulation, medium-density fiberboard or limber). Each material was assigned a percentage based on construction waste that is typical for the industry:

15%	Corrugated containers
5%	Concrete
15%	Drywall
20%	Mixed metals
20%	Mixed plastics
10%	Carpet
5%	Fiberglass insulation
5%	Medium-density fiberboard
5%	Lumber

*This breakdown was used for the following projects: Banfield Pet Hospital and Etsy (partial material stats were available).***

About Gensler

As architects, designers, planners, and consultants, we partner with our clients on some 3,000 projects every year. These projects can be as small as a wine label or as large as a new urban district. With more than 5,000 professionals networked across 44 locations, we serve our clients as trusted advisors, combining localized expertise with global perspective wherever new opportunities arise. Our work reflects an enduring commitment to sustainability and the belief that design is one of the most powerful strategic tools for securing lasting competitive advantage.

Gensler's Research Program supports research investigations important to our firm, our clients, and to the ongoing learning and development of Gensler professionals. Research projects are practitioner-led with involvement across the globe. Our teams bring thought leadership to the table as we seek to solve our clients' and the world's most pressing challenges by creating high-performance solutions that embrace the business and world context in which we work, enhance the human experience, and deliver game-changing innovation.

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BIBLIOGRAPHY

Administration, U. S. E. I. (2012). Commercial Buildings Energy Consumption Survey. Retrieved from https://www.eia.gov/consumption/commercial/data/2012/index.php?view=consumption#e1-e11

Agency, I. E. (2013). Transition to Sustainable Buildings: Strategies and Opportunities to 2050.

Agency, I. E. (2017). IEA finds CO2 emissions flat for third straight year even as global economy grew in 2016. International Energy Agency. https://www.iea.org/newsroom/news/2017/march/iea-finds-co2-emissions-flat-for-third-straight-year-even-as-global-economy-grew.html

Agency, U. S. E. P. (2017). Greenhouse Gas Equivalencies Calculator. Energy and the Environment. Retrieved from https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator

Airport, S. F. I. (2017). San Francisco International Airport's Strategic Plan, 2017 - 2021 [Press release]. Retrieved from https://www.flysfo.com/about-sfo/the-organization/strategic-5-year-plan

Architects, T. A. I. o. (2016). 2030 by the numbers: The 2016 summary of the AIA 2030 commitment.

Architecture2030. (2017). Architecture2030. Retrieved from http://architecture2030.org/about/

ASHRAE. (2017). Shaping Tomorrow's Built Environment. www.ashrae.org. Retrieved from https://www.ashrae.org/

Bank, T. W. (2017). Urban Development. Urban Development. Retrieved from http://www.worldbank.org/en/topic/urbandevelopment/overview

Conference, U. C. C. (2015). COP 21. Paper presented at the Paris Pledge for Action, Paris, France. http://www.parispledgeforaction.org/

Kira West, I. (2015). ETP 2015: Iron & steel findings. Paper presented at the Energy Technology Perspectives 2015.

Miller, S. A. (2016). Readily implementable techniques can cut annual CO2 emissions from the production of concrete by over 20%. Environmental Research Letters, 11(7), 7.

Nations, U. (2017). The New Urban Agenda: Key Commitments. Sustainable Development. Retrieved from http://www.un.org/sustainabledevelopment/blog/2016/10/newurbanagenda/

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